AC Servo System

Frequency Response **3.0**kHz

User Manual

Rev. 1.0

AMP & MOONS' Automation

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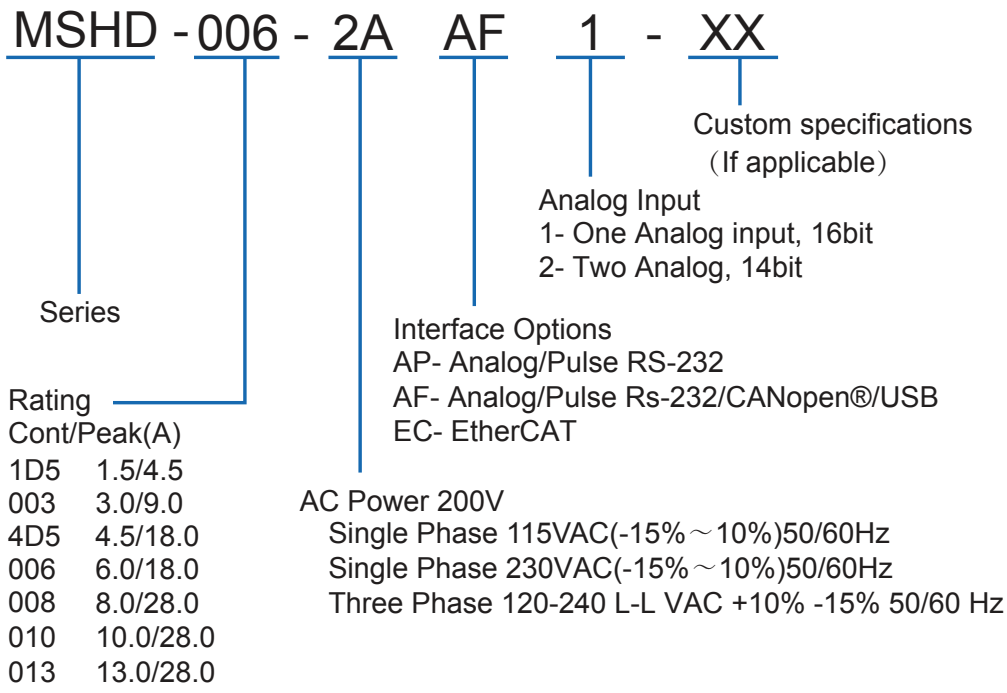
Part Number

For ordering the MSHD, refer to the following diagram:



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1 Introduction

1.1 Documentation

1.1.1 About This Manual

This manual describes the MSHD Servo Drive.

It provides the information required for installation, configuration and basic operation of the MSHD unit.

This document is intended for persons who are qualified to transport, assemble, commission, and maintain the equipment described herein.

1.1.2 Documentation Set for MSHD

This manual is part of a documentation set. The entire set consists of the

following:

- MSHD Quick Start Guide. Basic setup and operation of the drive.
- MSHD User Manual. Hardware installation, configuration and operation.
- MSHD VarCom Reference Manual. Parameters and commands used to program the MSHD.

1.2 Safety

Only qualified persons may perform the installation procedures. You do not need to be an expert in motion control to install and operate the drive system. However, you must have a basic understanding of electronics, computers, mechanics, and safety practices.

The MSHD utilizes hazardous voltages.
Be sure the drive is properly grounded.

Before you install the MSHD, review the safety instructions in this manual.Failure to follow the safety instructions may result in personal injury or equipment damage.

1.2.1 Safety Symbols

Safety symbols indicate a potential for personal injury or equipment damage if the recommended precautions and safe operating practices are not followed.The following safety-alert symbols are used on the drive and in the documentation:

	Caution	ISO 7000-0434 (2004-01)
	Warning.Dangerous voltage.	IEC 60417-5036 (2002-10)
	Protective earth; protective ground	IEC 60417–5019 (2006-08)
	Caution, hot surface	IEC 60417-5041 (2000-10)

1.2.2 Safety Instructions

- Read all available product documentation before assembling and commissioning. Incorrect handling of this product may cause personal injury and/or damage to equipment. Adhere strictly to the installation instructions and requirements.
- All system components must be connected to ground. Electrical safety is provided through a low-resistance earth ground connection. (Protective Class 1 according standard EN/IEC 618005-1.)
- This product contains static sensitive components that can be damaged by incorrect handling. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface. Ground yourself (discharge any possible static electricity build-up) by touching an unpainted, metal, grounded surface.
- Keep all covers and cabinet doors shut during operation. Otherwise, potential hazards may cause personal injury and/or damage to equipment.
- During operation the product has electrically charged components and hot surfaces. The heat sink can reach temperatures of 90°C. Control and power cables can carry a high voltage, even when the motor is not rotating.
- To avoid electric arcing and hazards to personnel and electric contacts, never disconnect or connect the product while the power source is energized.
- After removing the power source from the equipment, wait at least 5 minutes before touching or disconnecting sections of the equipment that normally carry electrical charges (e.g., capacitors, contacts, screwed connections). For safety, measure the electrical contact points with a meter before touching the equipment. Wait until the voltage drops below 30 VAC before handling components.
- Provide a power mains disconnect device in according with local regulations.
- Before testing and setting up, the manufacturer of the machine must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.
- Since the drive meets IP20, the end user must select an enclosure that permits safe operation of the drive. The enclosure must meet at least IP54 made of metal or material with rating flammability of 5 VA.
- Since the leakage current to PE is greater than 3.5 mA, compliance with IEC61800-5-1 requires that either the PE connection be doubled or a connecting cable with a cross-section greater than10 mm² be used. Use the PE terminal and the PE connection screws to meet this requirement.
- Wiring of green color with or without one or more yellow stripes must not be used except for protective bonding.

1.3 Standards Compliance

1.3.1 General Information

The MSHD has been successfully tested and evaluated according to standards IEC 61800-5-1. Conformance for UL 508C is in progress. This testing outlines the minimum requirements for electrically operated power conversion equipment (frequency converters and servo amplifiers), which are intended to eliminate the risk of fire, electric shock, or injury to persons.

UL 508C references UL 840, which describes the achievement by design of air and insulation creepage spacings for electrical equipment and printed circuit boards. The MSHD provides overload protection and current limit control.

The drive is intended for operation in pollution level 2 environment.

The terminals on the controller are coded so they can easily be identified in the instructions. The instructions identify the connections for the power supply, load, control, and ground.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes, or the equivalent.

1.3.2 CE Compliance

The MSHD is designed to comply with the following European directives. Formal certification is pending.

- EC Directive 2004/108/EC
  Electromagnetic Compatibility
  Standard EN 61800-3 (2004)
- LVD Directive 2006/95/EC
  Electrical Safety: Low voltage directive
  Standard IEC 61800-5-1 (2007)

1.4 Unpacking

The package contains the MSHD drive only.

1. Open the package and remove all packing materials.
2. Check to ensure there is no visible damage to the MSHD drive. If damage is detected, notify the carrier immediately.

2 Product Description

2.1 Overview

2.1.1 General Description

The MSHD is a full-featured, high-performance servo drive featuring innovative technologies and industry-leading power density.

Key features of the MSHD include:

- Support for rotary
- Operation in current, velocity and position control loops.
- Eleven digital inputs, six digital outputs, together with an analog input and output, to meet any I/O requirement.
- Various communication options.
- Various motor feedback options.
- Firmware customization to address special application requirements.
- OEM motors predefined in user interface to enable immediate integration.

2.1.2 Product Options

The MSHD product line offers a number of options (as of January 2012):

- 200VAC rating.
- Continuous current of 1.5, 3, 4.5,
- 6, 8 10 or 13 A rms for the 200 V models.
- One 16-bit or two 14-bit analog inputs.
- Various interface options, including analog voltage/pulse train and CANopen.

Refer to the part number diagram at the beginning of this manual for the various ordering options for the MSHD drive.

The primary 200 V product models are shown in Figure 2-1:

Figure 2-1. MSHDProduct Models (200V)2.2 Technical Specifications

2.2 Technical Specifications

2.2.1 Dimensions

The various models of the MSHD are housed in one of three frames. The exterior dimensions of the MSHD are shown in Figure 2-2 Figure 2-3 and Figure 2-4.

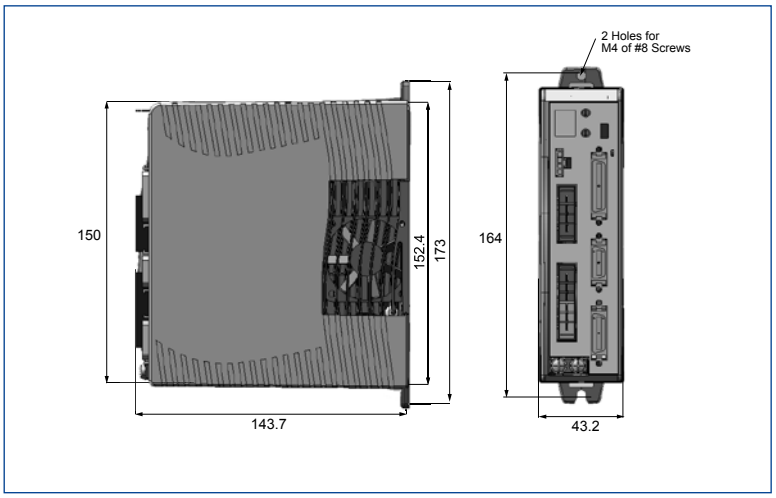


Figure 2-2. MSHD-1D5/MSHD-003 Dimensions (in mm)
Note: MSHD-003 shown here; MSHD-1D5 does not have fan.

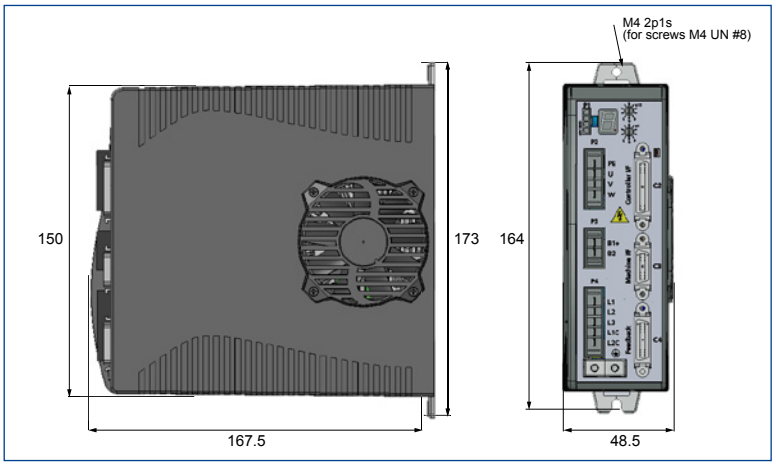


Figure 2-3. MSHD-4D5/MSHD-006 Dimensions (in mm)

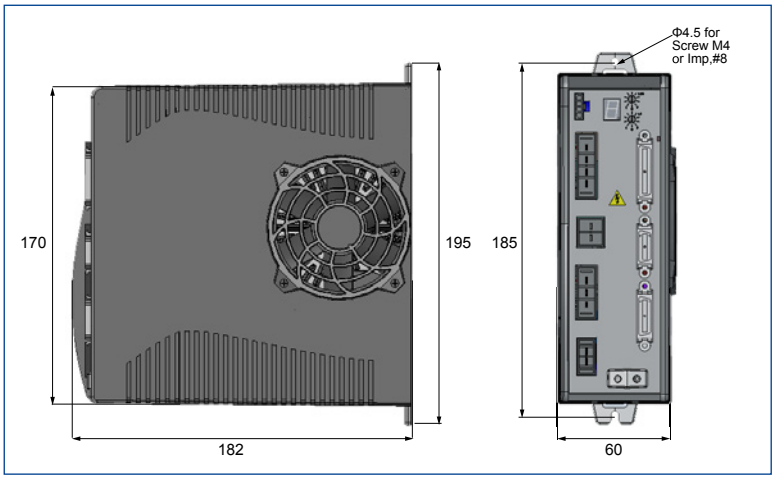


Figure 2-4. MSHD-008/MSHD-010/MSHD-013 Dimensions (in mm)

2.2.2 Mechanical and Electrical Specifications

Table 2-1. Mechanical & Electrical Specifications – MSHD-1D5/MSHD-003

Single and Three-Phase 200V	Specification	MSHD-1D5	MSHD-003
Ratings			
Input Power Circuit (L1, L2)	Voltage (VAC Line-Line) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120/240 VAC	1 Phase	1 Phase
	Continuous Current (1ph A rms)	2.5	5
	Line Fuses (FRN-R, LPN, or equivalent) (A)	10	10
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C, L2C)	120 or 240 VAC	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5
STO (Safe Torque Off)	STO Power Supply (VDC)	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5
Motor Output (U, V, W)	Continuous Output Current (A rms)	1.5	3
	Continuous Output Current (A peak)	2.12	4.24
	Peak Output Current (A rms) for 2 seconds	4.5	9
	Peak Output Current (A peak) for 2 seconds	6.3	12.72
	VA at 120 VAC	280	440
	VA at 240 VAC	370	740
	PWM Frequency (kHz)	16	16
Soft Start	Max. Surge Soft Start Current (A)	7	7
	Max. Charge Time (ms)	350	350
Power Circuit Loss	W		
Control Circuit Loss	W	5	5
Total Power Loss	W		
Hardware			
Unit Weight	kg	0.7	0.75
Connection Hardware	PE Ground Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24-28	24-28
	Main Circuit Motor Lines (AWG)	18	18
	Main Circuit AC Inputs (AWG)	18	18
	PE Ground Screw	4	4
Clearance Distance	Side-to-Side (mm)	15	15
	Top/Bottom (mm)	50	50
Voltage Trip			
	Under-Voltage Trip (Nominal) (VDC)	100	100
	Over-Voltage Trip (VDC)	420	420

Single and Three-Phase 200V	Specification	MSHD-1D5	MSHD-003
Power Temperature			
Fan	Normally operates at quarter power; when-temperature exceeds high-speed fan trigger temperature, operates at full power	No	Yes
	Power Module Over-Temperature Fault Regulated (°C)	±80	±80
	Power Module Over-Temperature Fault Non-regulated (°C)	±100	±100
	Trigger Temperature for High Speed Fan (°C)	NA	60
Regen External Regenerative Resistor (B1+, B2)			
External Shunt Regulator	Peak Current (A)	6.3	12.7
	Minimum Resistance (Ω)	64	31.5
	W	Systemde-pendent	Systemde-pendent
Application Information	Internal Bus Capacitance (μF)	380	380
	Bus Voltage (Nominal) (VDC)	320	320
	Bus Voltage (Nominal) 120 (VDC)	170	170
	Bus Voltage (Nominal) 240 (VDC)	340	340
	VHYS (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

Table 2-2. Mechanical & Electrical Specifications – MSHD-4D5/MSHD-006/MSDH-013

Single and Three-Phase 200V	Specification	MSHD-4D5	MSHD-006
Ratings			
Input Power Circuit (L1, L2, L3)	Voltage (VAC Line-Line) Nominal ±10%	120/240	120/240
	Line Frequency (Hz)	50/60	50/60
	120 VAC	1 Phase or 3 Phase	1 Phase or 3 Phase
	240 VAC	1 Phase	1 Phase
	Continuous Current (1 ph/3 ph A)		10/7
	Line Fuses (FRN-R, LPN, or equivalent)	15	15
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C, L2C)	120 or 240 VAC	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5
STO (Safe Torque Off)	STO Power Supply (VDC)	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5
Motor Output (U, V, W)	Continuous Output Current (A rms)	4.5	6
	Continuous Output Current (A peak)	6.63	8.48
	Peak Output Current (A rms) for 2 seconds	18	18
	Peak Output Current (A peak) for 2 seconds	25.45	25.45
	VA at 120 VAC		900
	VA at 240 VAC		1300
	PWM Frequency (kHz)	16	16
Soft Start	Max. Surge Soft Start Current (A)	7	7
	Max. Charge Time (ms)	250	250
Power Circuit Loss	W		
Control Circuit Loss	W	5	5
Total Power Loss	W		
Hardware			
Unit Weight	kg	0.97	0.97
Connection Hardware	PE Ground Screw Size/Torque	M4/1.35 Nm	M4/1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24-28	24-28
	Main Circuit Motor Lines (AWG)	16	16
	Main Circuit AC Inputs (AWG)	16	16
	PE Ground Screw	4	4
Clearance Distance	Side-to-Side (mm)	15	15
	Top/Bottom (mm)	50	50
Voltage Trip			
	Under-Voltage Trip (Nominal) (VDC)	100	100
	Over-Voltage Trip (VDC)	420	420

Power Temperature			
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	No	Yes
	Power Module Over-Temperature Fault Regulated (°C)	±80	±80
	Power Module Over-Temperature Fault Non-regulated (°C)	±100	±100
	Power Module Over-Temperature Fault (°C)		
	Trigger Temperature for High Speed Fan (°C)	60	60
Regen External Regenerative Resistor (B1+, B2)			
External Shunt Regulator	Peak Current (A)	25.5	25.5
	Minimum Resistance (Ω)	16	16
	W	Systemde-pendent	Systemde-pendent
Application Information	Internal Bus Capacitance (μF)	1120	1120
	Bus Voltage (Nominal) (VDC)	320	320
	VHYS (Regen Circuit Turn Off) (VDC)	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400

Table 2-3 Mechanical & Electrical Specifications - MSHD-008/MSHD-010/MSHD-013

Single and Three-Phase 200V	Specification	MSHD-008	MSHD-010	MSHD-013
Ratings				
Input Power Circuit (L1, L2, L3)	Voltage (VAC Line Line) Nominal ±10%	120/240	120/240	120/240
	Line Frequency (Hz)	50/60	50/60	50/60
	120/240 VAC	3 Phase	3 Phase	3 Phase
	Continuous Current (1 ph/3 ph A)			16/10.6
	Line Fuses (FRN-R, LPN, or equivalent)	20	20	20
	Withstand Voltage (Primary to Earth)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)	1500 VAC (2121 VDC)
Control Circuit Input Power (L1C, L2C)	120 or 240 VAC	1 Phase	1 Phase	1 Phase
Logic Input Fuse (Time Delay)	120 or 240 VAC (A)	0.5	0.5	0.5
STO (Safe Torque Off)	STO Power supply (VDC)	24 ±10%	24 ±10%	24 ±10%
STO Fuse (Time Delay)	120 or 240 VAC (A)	1.5	1.5	1.5
Motor Output (U, V, W)	Continuous Output Current (A rms)	8	10	13
	Continuous Output Current (A peak)	11.31	14.14	18.38
	Peak Output Current (A rms) for 2 seconds	28	28	28
	Peak Output Current (A peak) for 2 seconds	39.56	39.56	39.56
	VA at 120 VAC			1700
	VA at 240 VAC			2800
	PWM Frequency (kHz)	8	8	8
Soft Start	Max. Surge Soft Start Current (A)	15	15	15
	Max. Charge Time (ms)	350	350	350
Power Circuit Loss	W			
Control Circuit Loss	W	5	5	5
Total Power Loss	W			
Hardware				
Unit Weight	kg	1.15	1.15	1.15
Connection Hardware	PE Ground Screw Size/Torque	M4/ 1.35 Nm	M4/ 1.35 Nm	M4/ 1.35 Nm
Wire Size	Control Circuit (AWG) up to 3 meters	24-28	24-28	24-28
	Main Circuit Motor Lines (AWG)	14	14	14
	Main Circuit AC Inputs (AWG)	14	14	14
	PE Ground Screw	4	4	4
Clearance Distance	Side-to-Side (mm)	15	15	15
	Top/Bottom (mm)	50	50	50
Voltage Trip				
	Under-Voltage Trip (nominal) (VDC)	100	100	100
	Over-Voltage Trip (VDC)	420	420	420

Power Temperature				
Fan	Normally operates at quarter power; when temperature exceeds high-speed fan trigger temperature, operates at full power	Yes	Yes	Yes
	Power Module Over-Temperature Fault Regulated (°C)	±80	±80	±80
	Power Module Over-Temperature Fault Non regulated (°C)	±100	±100	±100
	Power Module Over-Temperature Fault (°C)	100	100	100
	Trigger Temperature for High Speed Fan (°C)	60	60	60
Regen External Regenera-tive Resistor (B1+, B2)				
External Shunt Regulator	Peak current (A)	40	40	40
	Minimum resistance (Ω)	10	10	10
	W	System-dependent	System-dependent	System-dependent
Application Information	Internal Bus Capacitance (μF)	2110	2110	2110
	Bus Voltage (Nominal) (VDC)	320	320	320
	VHYS (Regen Circuit Turn Off) (VDC)	380	380	380
	VMAX (Regen Circuit Turn On) (VDC)	400	400	400

2.2.3 Control Specifications

Table 2-4.Control Specifications – All 200 VAC Models

Feature	Specification	
Motors		Rotary servomotors
	Auto-configuration	Automatic self-configuration of motor phasing and wire settings
Operation Mode	Selectable Modes	Serial or analog current (torque), Serial or analog velocity, serial or Pulse and Direction position
Current (Torque) Control	Input/Output	Current command / 3 phase PWM command
	Performance	Update rate 31.25 µs (32 kHz), Output waveform sinusoidal
	Step Response Time	Actual current reaches command in two cycles, 62.5 µs
	Control Loop	DQ, PI, Feed-forward
	Reference Command	Analog ±10 VDC, Serial, CANopen
	Autotuning	Automatic self-tuning of current control loop parameters
Velocity Control	Input/Output	Velocity command / Current command
	Performance	Update rate 125 µs (8 kHz)
	Selectable Velocity Control Loops	PI , PDFF, Standard pole placement, Advance pole placement, Standard pole placement high frequency, Pole placement with active dumping
	Filters	First order low pass filter, Double first low pass filter, Notch, High pass filter, Band pass filter, User defined polynominal filter
	Reference Command	Analog ±10 VDC, Serial, CANopen
Position Control	Input/Output	Position command / Velocity command
	Performance	Update rate 250 µs (4 kHz)
	Control loop	PID and feed-forward
	Reference Command	Pulse and direction, Serial, CANopen
HD Control	Input/Output	Position command or Velocity command/Current command
	Performance	Update rate 250 µS (4 kHz)
	Control Loop	Non-linear control algorithm provides very low tracking error, zero or minimum settling time and smooth movement; includes an adaptive feed-forward feature that is applied at end of movement end to achieve zero or minimum settling time.
	Filters	One second order low pass, two notch, and other filters to handle flexible and resonant systems
	Reference Command	Velocity command: Analog ±10 VDC, Serial, CANopen Position command: Pulse and direction, Serial, CANopen
	Autotuning	Automatic inertia load measurement, self-tuning and optimization of HD control loop parameters. Optimal settling time up to 0-2 ms
Brake	Method	Control stops: Dynamic brake, Active disable
Display	Method	7-segment LED (green), display drive status
GUI	User Interface	ServoStudio Windows-based application
	Function	Setting connection, Drive info, Power display, Motor, Feedback, I/O selection/configuration, Motion setting/tuning, Fault history/display, Setup wizard, Expert view
Rotary Units	Position	Revolutions, Counts, Degrees, User-defined
	Velocity	rps, rpm, deg/s, user/s
	Acceleration/Deceleration	rps/s, rpm/s, deg/s2, user/s^2

2.2.4 Protective Functions and Environmental Specifications

Table 2-5. Protective Functions and Environmental Spec. – All 200 VAC Models

Feature	Specification
Protective Functions	Under- and over-voltage, Over-current, Drive and motor over-temperature, Foldback, Feedback lost, Safety function (STO)
Compliance Standard	UL - UL508c (compliance testing in progress)
	CE - EMC Directive 2004/108/EC, standard IEC61800-3,
	CE Low Voltage Directive 73/23/EEC IEC61800-5-1
	STO - Safe Torque Off (compliance testing in progress)
	RoHS
Environment	Ambient temperature: Operation 0-45°C, Storage 0-70°C
	Humidity: 10-90%
	Altitude: < 1000m. If >1000m, derate 5% per 330m
	Vibration: 0.5g
Protection class/ Pollution degree	Protection class: IP20, pollution degree: 2 as per IEC 60664-1 Do not use in the following locations: corrosive or flammable gasses, water oil or chemical, dust including iron dust and salts
Configuration	Book mounting

2.2.5 Communication Specifications

Table 2-6. Communication Specifications – All 200 VAC Models

Feature	Specification
CAN*	CANopen – CiA 301 application layer and the CiA 402 device profile for drives and motion control
	Baud rate 0.5M 1M bit/s
RS232	ASCII-based, ServoStudio, HyperTerminal
	Baud rate 9600 to 115200 bit/s
	Maximum cable length 10 m
USB*	ASCII-based, ServoStudio, HyperTerminal
	Baud rate 9600 to 115200 bit/s
	Maximum cable length 3 m
Daisy Chain	Up to 8 axes Axis address setting from 0-99 using two rotary switches
	Maximum cable length 10 m

*Some features are not available on all models. Check the ordering options at the front of the manual, or contact your supplier.

2.2.6 I/O Specifications

Table 2-7. I/O Specifications – All 200 VAC Models

Feature	Specification	
First Analog Input	Voltage Range	Analog ±10 VDC differential
	Input Resolution	16 bit (14-bit on version with two analog inputs)
	Input Impedance	8 kΩ (when using two analog inputs 20k Ω.)
Second Analog Input (optional)	Voltage Range	Analog ±10 VDC differential 14 bit
	Input Resolution	14 bit
	Input Impedance	20 kΩ
Equivalent Encoder Output	Signal	A-quad-B and marker differential, RS 422 line transmitter
8x Digital Inputs	Signal	Configurable opto-isolated (compatible with sinking output)
	Voltage	24 V
	Max. Input Current	10 mA
	Propagation Delay Time	1 ms
3x Fast Digital Inputs	Signal	Configurable opto-isolated (compatible with sinking output)
	Voltage	24 V
	Max Input Current	10 mA
	Propagation Delay Time	1 µs
4x Digital Output *	Signal	Configurable open collector, opto-isolated sinking output
	Voltage	24 V
	Max. Current	40 mA
	Propagation Delay Time	1 ms
2x Fast Digital Output	Signal	Configurable open collector, opto-isolated sinking output
	Voltage	24 V
	Max current	10 mA
	Propagation Delay Time	1 µs
Analog Output	Signal	Configurable analog output
	Voltage Range	0-10 V
	Resolution	8 bit
	Max. Load	1 kΩ
Secondary Feedback	Signal	A-quad-B and marker differential, RS 422 line receiver
	Max. Input frequency	3 MHz (before A-quad-B)
	Functions	Dual loop, Master/Slave or Handwheel
Fault Output Relay	Signal	Configurable dry contacts
	Voltage	24V
	Max. Current	1 A

2.2.7 Motor Feedback Specifications

Table 2-8. Motor Feedback Specifications – All 200 VAC Models

Motor Feedback	Specification	
General	Supply Voltage from Drive	5 VDC (7 VDC*)
	Max. Supply Current from Drive	250 mA
	Max. Cable Length	AWG 28 – 3 m AWG 2 – 10 m
	Velocity estimation	Improved algorithm for velocity measurements
Incremental Encoder	Signal	A-quad-B with or without marker/Halls, 8 channel Tamagawa, RS 422 or RS485 line receiver, Differential
	Max Input Frequency	3 MHz (before quadrature)
Hall Sensor	Signal	Open collector single-ended
Resolver (Please contact us for more information)	Signal	Sine/cosine differential
	Transformation Ratio	0.45-1.6
	Excitation Frequency	8 kHz
	Input Voltage from Drive	6-22 Vpp
	Max. DC Resistance	120 Ω (stator)
	Max. Drive Current	55 mA rms
	Output Voltage to Drive	10 Vpp
Sine Encoder (Please contact us for more information)	Signal	Sine/Cosine differential, with or without Halls
	Signal Level	1 Vpp @ 2.5 V
	Max. Input Frequency	270 kHz
	Protocols	EnDat® 2.1, Hiperface®
	Input Impedance	120 Ω
	Maximum Drive Internal Interpolation	4096
SSI Encoder (Please contact us for more information)	Signal	Differential data and clock for synchronous encoders Data only for asynchronous encoders
	Protocols	EnDat 2.2, BiSS-C, other SSI
Motor Temperature	Signal	Thermal resistor PTC or NTC, User-defined fault threshold

* Some features are not available on all models. Check the ordering options at the front of the manual, or contact your supplier.

2.3 System Wiring - Pin Assignments

For more information, refer to the section Electrical Installation.

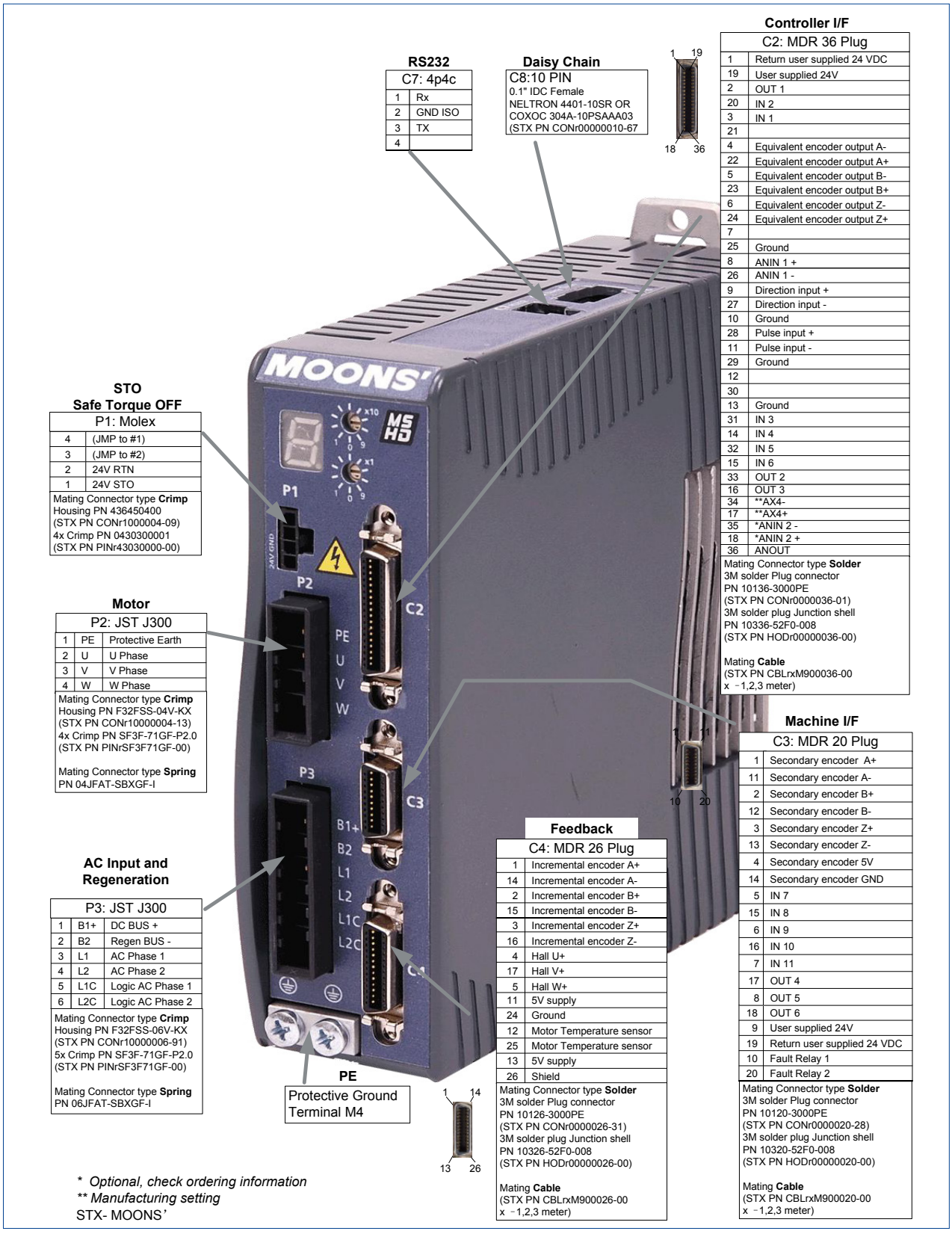


Figure 2-5. Pin Assignments on MSHD-1D5/MSHD-003

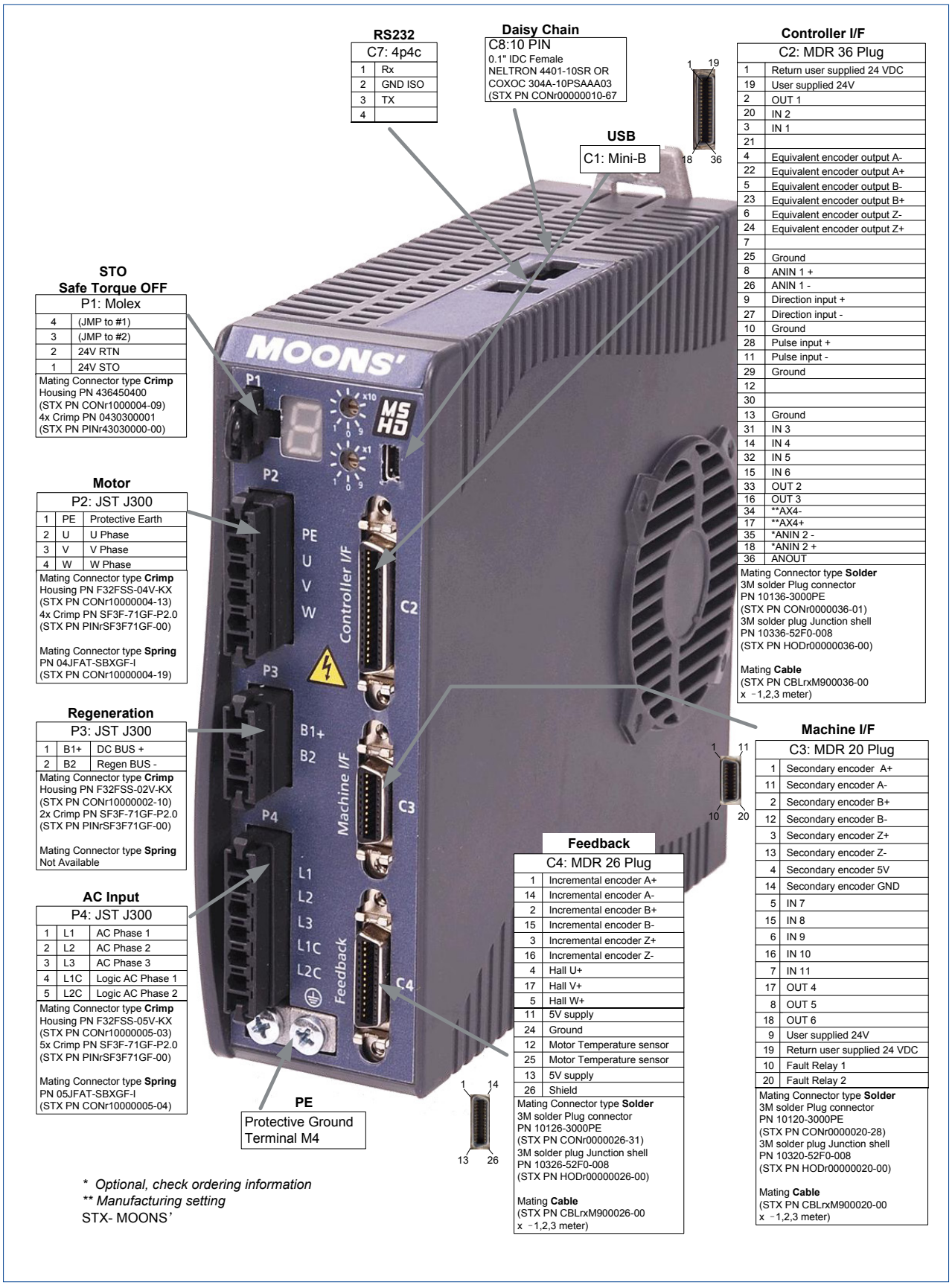


Figure 2-6. Pin Assignments on MSHD-4D5/MSHD-006

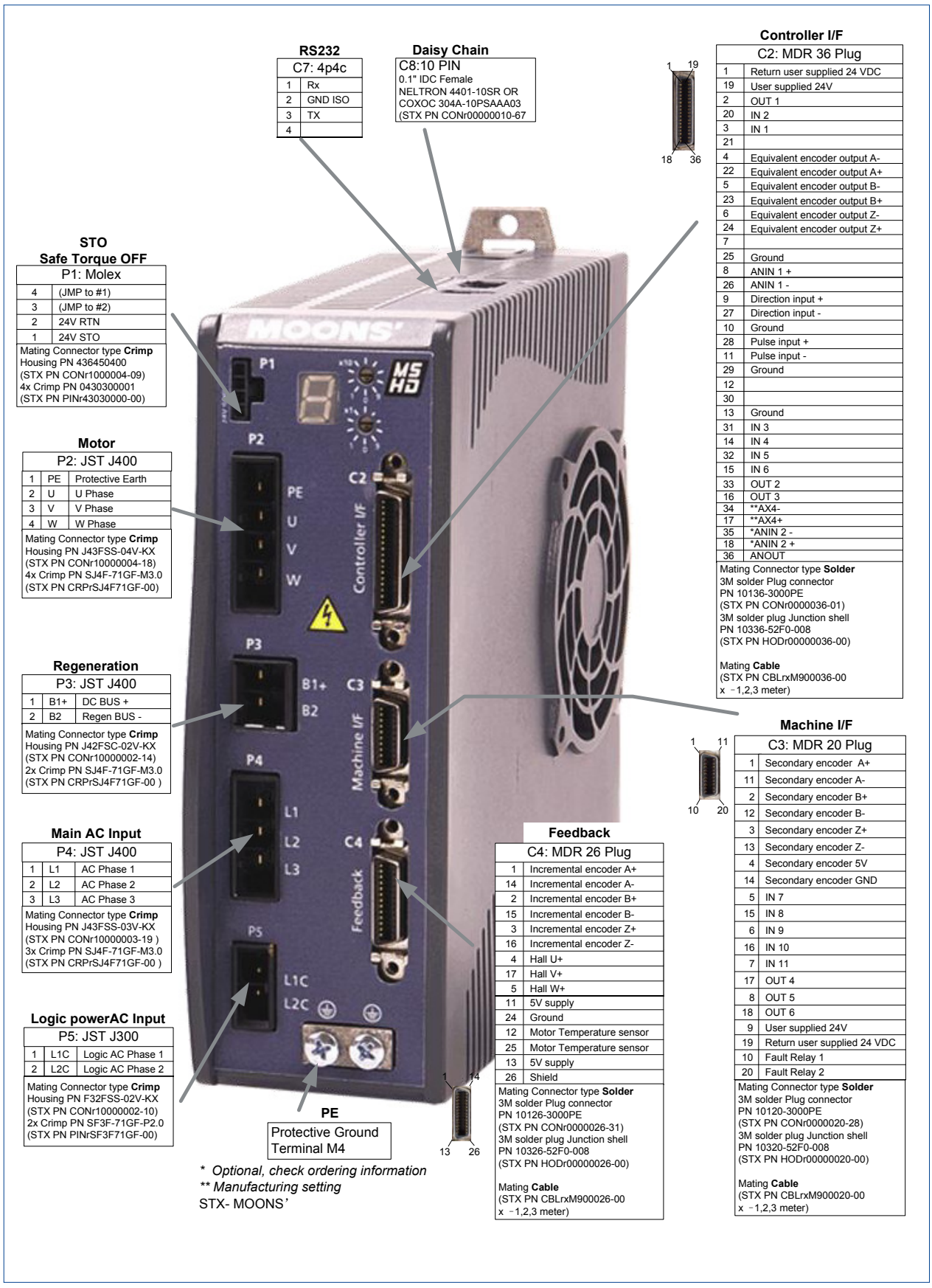


Figure 2-7. Pin Assignments on MSHD-008/MSHD-010/MSHD-013

2.4 Controller Interface Wiring

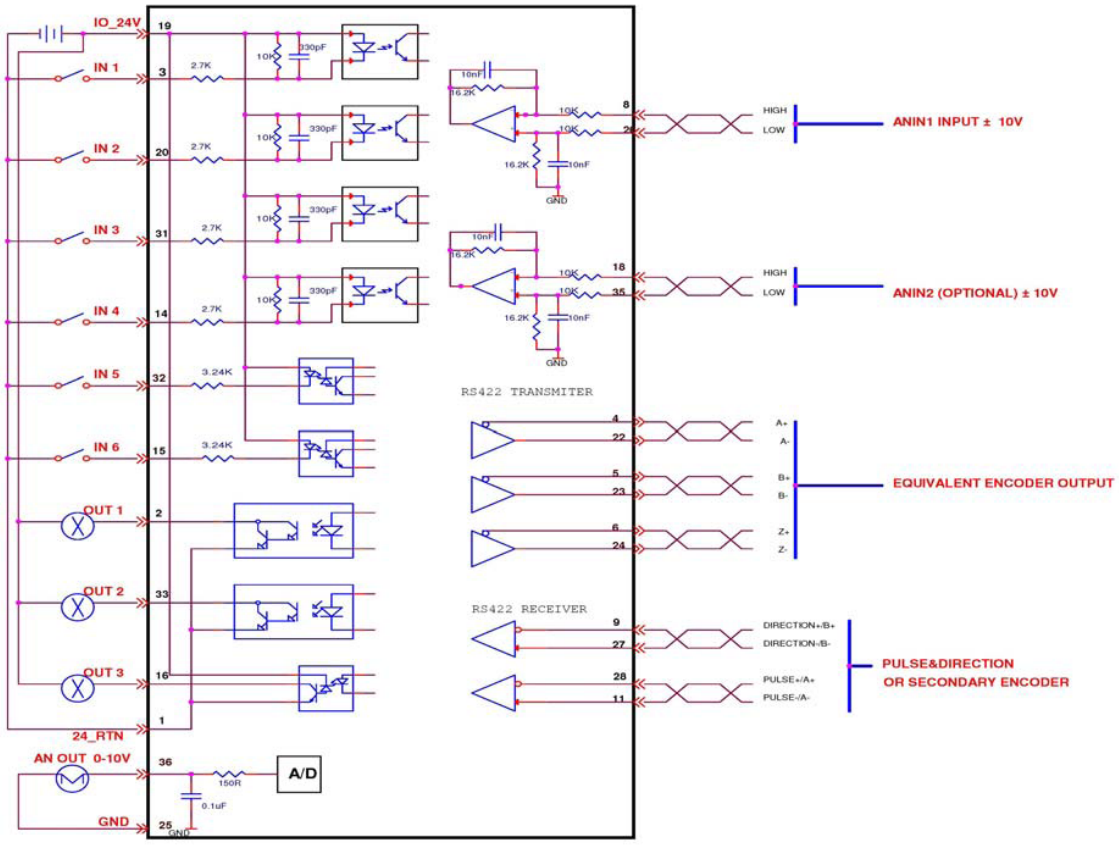


Figure 2-8. Controller Interface Wiring Diagram

2.5 Machine Interface Wiring

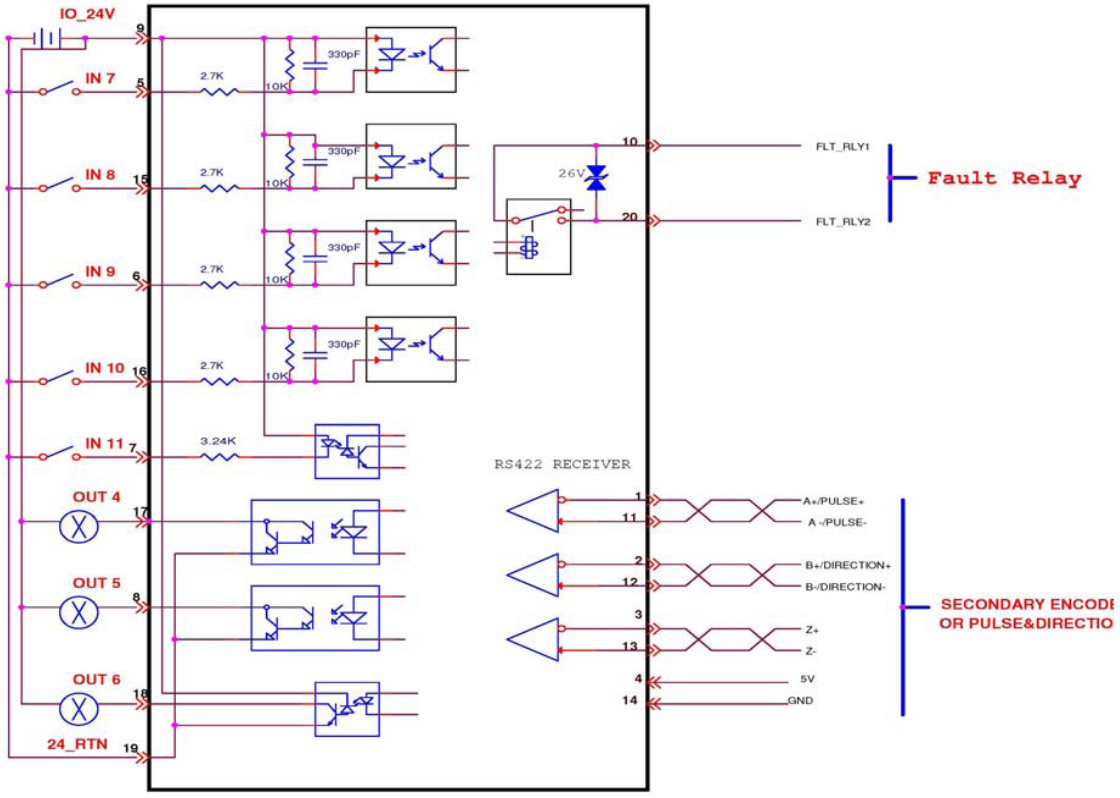


Figure 2-9. Machine Interface Wiring Diagram3 Installation

3 Installation

3.1 Installation Overview

Perform the following steps to install and setup a MSHD system.

1. Mount the MSHD.
2. Connect the motor to P2.
3. Connect safe torque off (STO) to P1, or use jumpers to bypass.

Refer to the section Connect STO.

4. Connect regen resistor to pins B1+ and B2 on P3, if required.
5. Connect motor feedback to C4.
6. Connect machine I/Os to C3 and/or controller I/Os at C2.
7. Connect AC input voltage.

Note: This interface varies among models.

Refer to the section Connect AC Input Voltage.

8. Set the drive address using the rotary switches.
9. Connect the drive to the PC.
10. Power up the drive and the PC.
11. Install ServoStudio software.
12. Using ServoStudio, configure and test the drive.

3.2 Preparation

3.2.1 Hardware Requirements

The following hardware is required for installation.

- Mating connectors and the associated crimp pins for interfaces P1, P2, P3, and P4 (all models) and P5 (only for MSHD-008, MSHD-010 and MSHD-013).
- Mating connectors for interfaces C2, C3 and C4:
    - Connector C2 (Controller I/O):
      Plug 3M 10136-3000PE and shell 3M 10336-52F0-008
    - Connector C3 (Machine I/O):
      Plug 3M 10120-3000PE and shell 3M 10320-52F0-008
    - Connector C4 (Motor Feedback):
      Plug 3M 10126-3000PE and shell 3M 10326-52F0-008
- Wires for connectors:
    - Connector P1: 26–28 AWG for all models.
    - Connectors P2, P3, and P4:
      18 AWG – for MSHD-1D5 and MSHD-003
      16 AWG – for MSHD-4D5 and MSHD-006
      14 AWG – for MSHD-008, MSHD-010 and MSHD-013

    - Connector P5 (only for MSHD-008, MSHD-010 and MSHD-013): 16 AWG
    - Connectors C2 (Controller I/O), C3 (Machine I/O) and C4 (Motor Feedback): 24–28 AWG.
- Crimping tools, if you are not using ready-made cable assemblies:
    - Connector P1: Molex crimper 0638190000
    - Connectors P2, P3, P4, P5: JST crimper YRF-1070.

      If a crimp pin extraction tool is needed, use JST extraction tool EJ JFAJ3.
- M4 ring or spade terminal.
- A small slotted screwdriver for setting the drive address switches.
- For connection to the host computer, use one of the following:
    - USB 2.0 A to Mini-B cable (USB interface)
    - 4p4c plug and cable (RS232 interface)

Crimping

Prior to crimping, strip 2 mm at the end of wire, as shown in Figure 3-1.

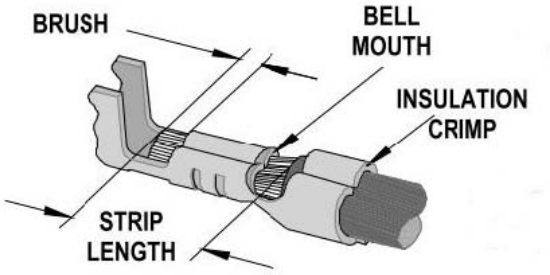


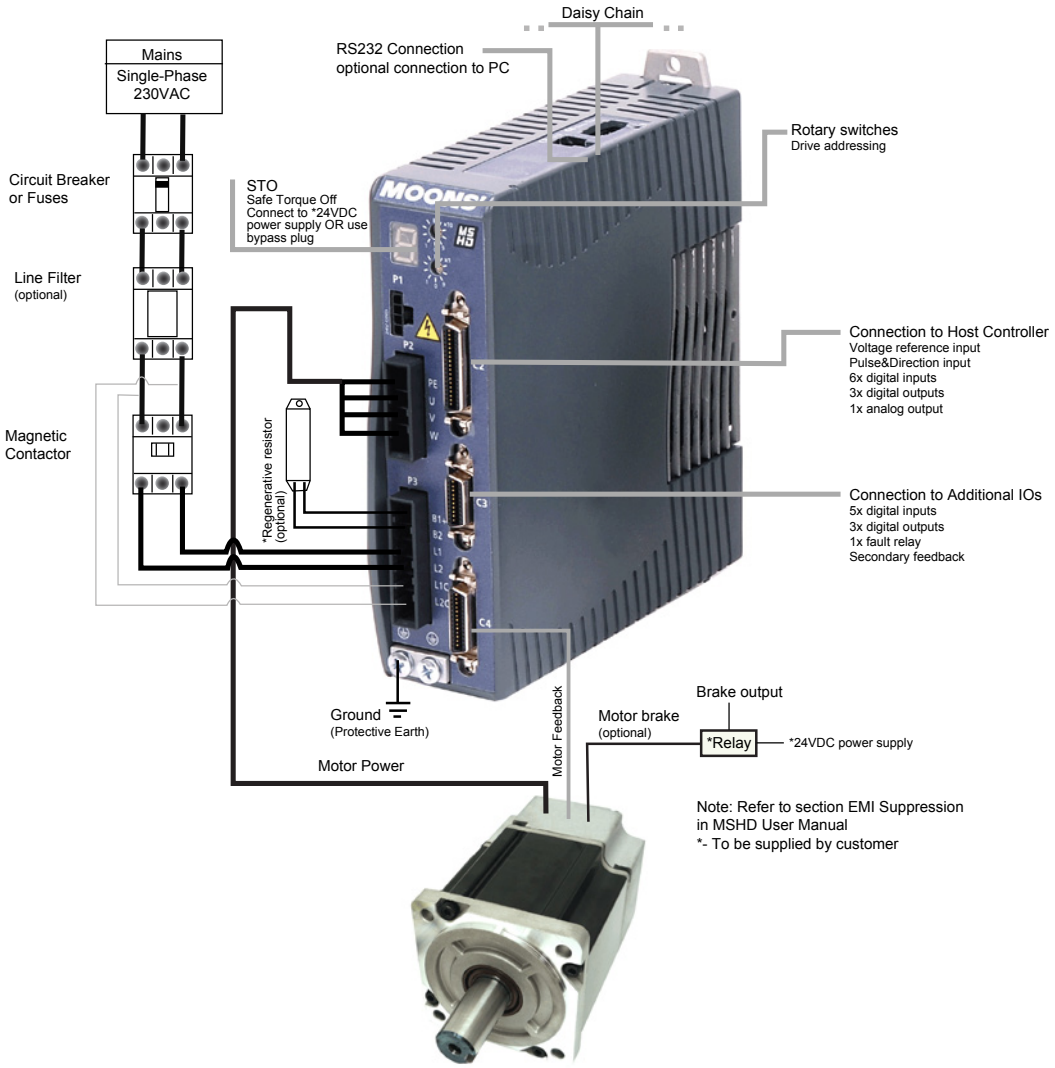
Figure 3-1. Stripped Wire in Crimp Pin

3.2.2 Computer System

The following computer system and software are required:

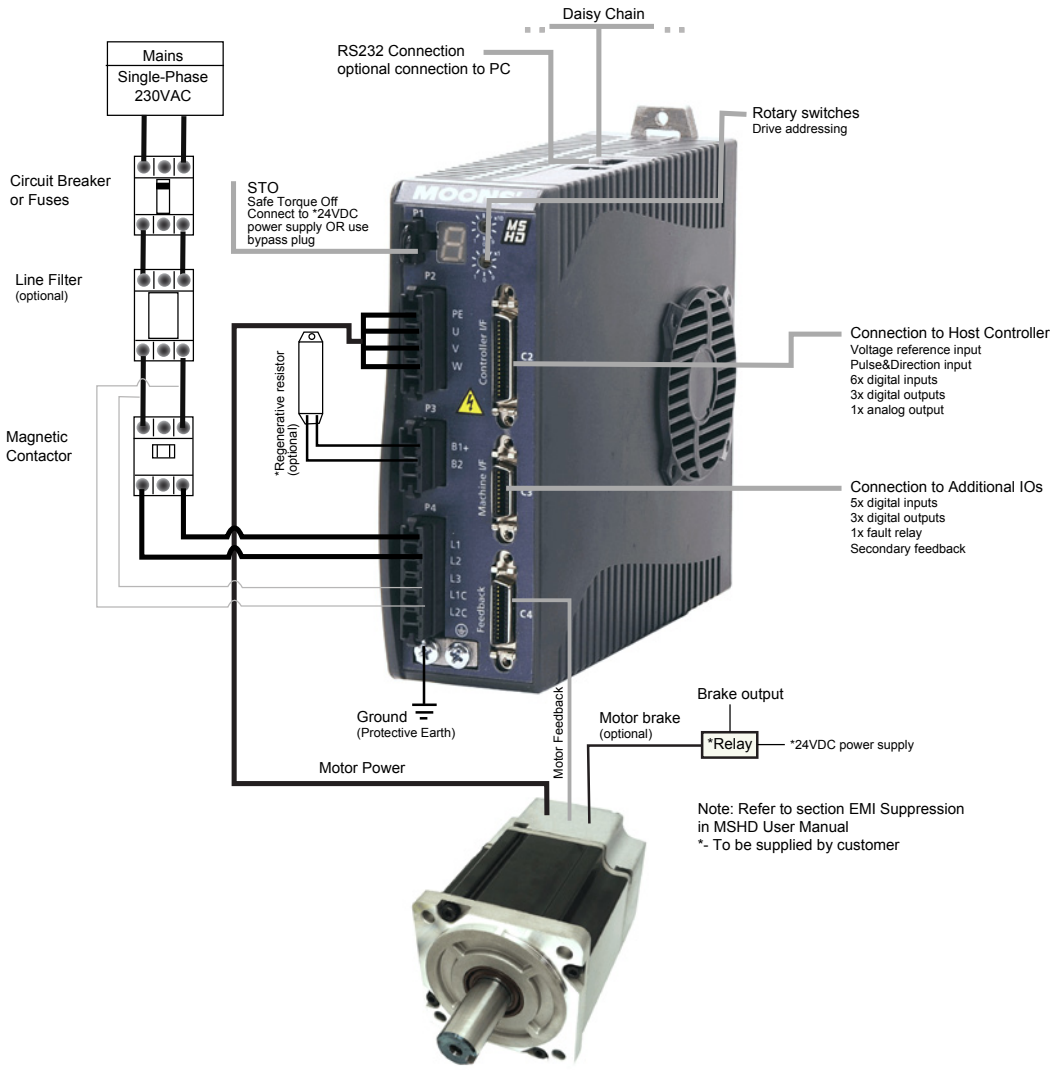
- 2 GHz CPU
- 1 MB RAM
- 1000 MB available on hard drive (after .net 4 is installed)
- USB port for connecting to the drive
- Operating system: Windows XP-SP3, or Windows 7
- ServoStudio, the graphical software interface for configuring and testing the drive. Download from the MSHD product page on the website.
- .Net4 (for details, refer to .NET Framework System Requirements). If .NET 4 is not installed on the computer, ServoStudio will guide you through the installation, but will not install it automatically.

3.2.3 Servo System Wiring



AC supply for the main power input(L1 L2) and for the logic power input(L1C L2C) must be from the same AC phase input, as show in the diagram.

Figure 3-2. MSHD-1D5/MSHD-003 Servo System Wiring, Using Single-Phase 230 VAC



AC supply for the main power input(L1 L2) and for the logic power input(L1C L2C) must be from the same AC phase input, as show in the diagram.

Figure 3-3. MSHD-4D5/MSHD-006 Servo System Wiring, Using Single-Phase 230 VAC

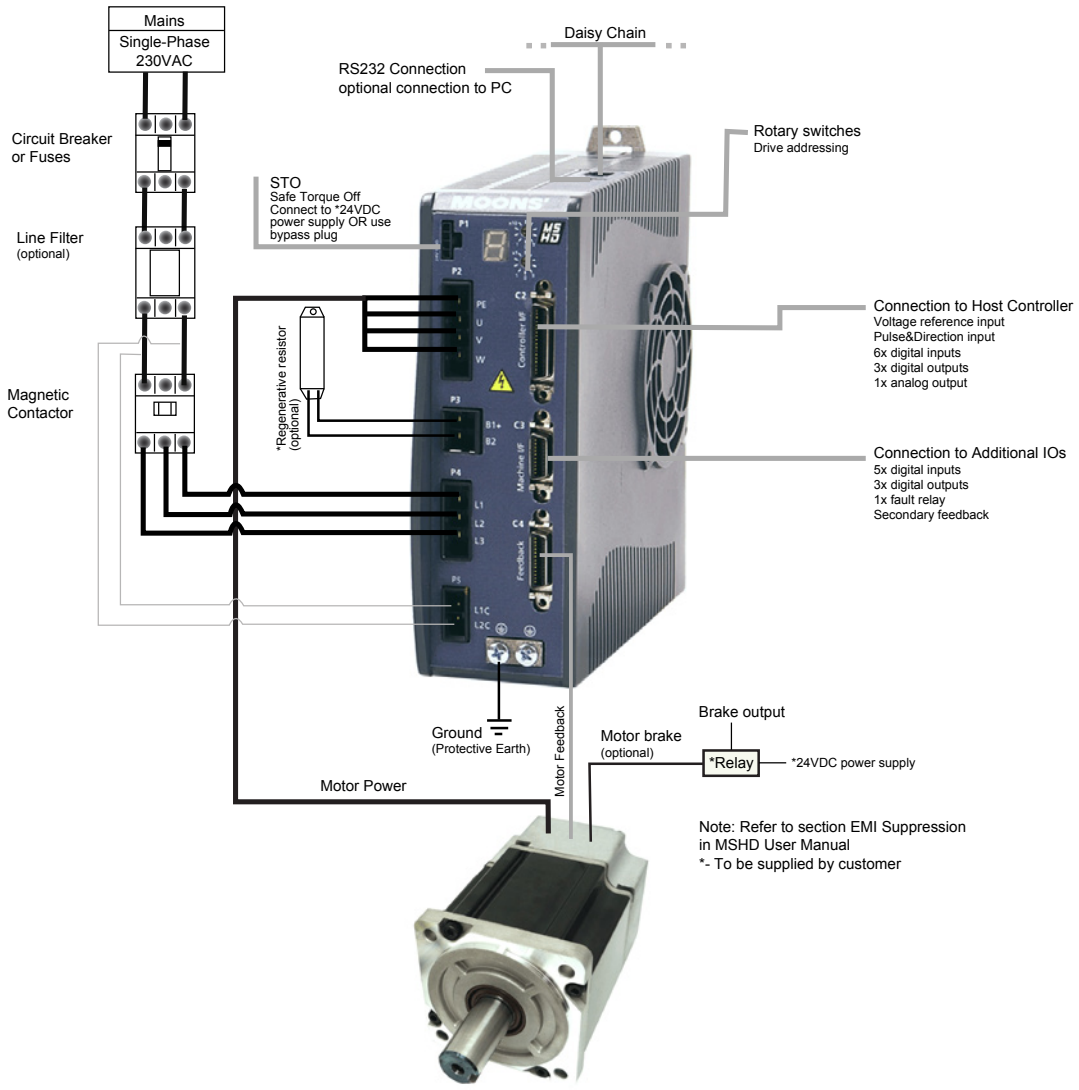


Figure 3-4. MSHD-008/MSHD-010/MSHD-013 Servo System Wiring, Using Three-Phase 230 VAC

3.3 EMI Suppression

3.3.1 CE Filtering Techniques

The MSHD drive complies with the CE standards specified in the section Standards Compliance. Proper bonding, grounding and filtering techniques must be applied in order to meet this standard.

Noise currents often occur in two types. The first is conducted emissions that are passed through ground loops. The quality of the system grounding scheme inversely determines the noise amplitudes in the lines. These conducted emissions are of a common-mode nature from line to neutral (or ground). The second is radiated high-frequency emissions usually capacitively coupled from line-to-line and are differential in nature.

To properly mount the EMI filters, the enclosure should have an unpainted metallic surface. This allows for more surface area to be in contact with the filter housing and provides a lower impedance path between this housing and the back plane. The back panel, in turn, has a high frequency ground strap connection to the enclosure frame or earth ground.

3.3.2 Grounding

System grounding is essential for proper performance of the drive system.

The AC input voltage ground wire must be connected to the PE terminal, located on the MSHD front panel. This is necessary for both safety and EMI reduction.

Use a single point ground for the system (start wiring) to avoid ground loops.

It is strongly recommended that the MSHD be mounted to a metallic back panel, and that a high frequency ground be provided to connect the back panel to earth ground. Provide an electrical connection across the entire back surface of the drive panel. Electrically-conductive panels such as aluminum or galvanized steel are recommended. For painted and other coated metal panels, remove all coating behind the drive. The objective is to provide an extremely low impedance path between the filters, drives, power supplies, and earth ground for highfrequency signals that might cause EMI. Use a flat braid or copper bus bar to achieve high-frequency grounding. When connecting high frequency grounds, use the shortest braid possible.

Ensure good connections between the cabinet components. Connect the back panel and cabinet door to the cabinet body using several conductive braids. Never rely on hinges or mounting bolts for ground connections. Ensure good ground connection from cabinet to proper earth ground. Ground leads should be the same gauge as the leads to main power or one gauge smaller.

3.3.3 Shielding and Bonding

Motor and feedback cables must be shielded in order to minimize noise emissions and increase the immunity levels of the drive system. The shield should be connected to ground at both ends.

The proper bonding of shielded cables to a grounded surface is imperative for minimizing noise emissions and increasing immunity levels of the drive system. Its effect is to reduce the impedance between the cable shield and the back panel. It is recommended that all shielded cables be bonded to the back panel.

The motor and feedback cables should have the shield exposed as close to the drive as possible. This exposed shield is bonded to the back panel using either non-insulated metallic cable clamps or cable bonding clamps.

It is recommended to use a star point shield connection, for example with a shielding busbar.

For cables entering a cabinet, connect shields on all 360° of the cable.

Lines between servo drives and filters and external brake resistor must be shielded.

3.3.4 Input Power Filtering

The MSHD electronic system components require EMI filtering in the input power leads to meet the CE/EMC requirements for the industrial environment. This filtering blocks conducted type emissions from exiting onto the power lines and provides a barrier for EMI on the power lines.

Care must be taken to adequately size the system. The type of filter is determined according to the voltage and current rating of the system and whether the incoming line is single- or three-phase. One input line filter can be used for multi-axis control applications.

Implementation of the input power filter must adhere to the following guidelines:

- Maintain separation of leads entering and exiting the mains filter.
- Filter must be mounted on the same panel as the drive.
- Filter must be mounted as close as possible to the drive, to prevent noise from being capacitively coupled into other signal leads and cables..
- When mounting the filter to the panel, remove any paint or material covering. Use an unpainted metallic back panel, if possible.
- Filters are provided with a ground connection. All ground connections must be tied to ground.
- Filters can produce high leakage currents. Filters must be grounded before connecting the supply!
- Filters should not be touched for 10 seconds after removing the supply.

3.3.5 Motor Line Filtering

Motor line filtering using ferrite cores might be necessary for CE compliance of MSHD systems. This additional filtering can increase the reliability of the system. Poor non-metallic enclosure surfaces and lengthy, unbonded (or unshielded) motor cables that couple noise line-to-line (differential) are just some of the factors that lead to the necessity of motor lead filtering.

Motor lead noise may be either common-mode or differential. The commonmode conducted currents occur between each motor lead and ground (line-toground). Differential radiated currents exist from one motor lead to another (line-to-line). The filtering of the lines feeding the motor provides additional attenuation of noise currents that enter surrounding cables and equipment I/O ports in close proximity.

3.3.6 I/O Signal Filtering

I/O filtering may be desirable (depending on system installation, application, and integration with other equipment). To avoid unwanted signals entering and disturbing the drive system or other associated equipment, place ferrite cores on I/O lines.

3.3.7 Additional EMI Suppression Recommendations

Route power and control cables separately. A distance of at least 200 mm is recommended, and improves the interference immunity.

If input power and motor leads need to cross, make sure they cross at 90°.

Feedback lines may not be extended, since this would cause the shielding to be interrupted, and possibly disturb the signal processing.

Splice cables properly. If you need to divide cables, use connectors with metal backshells. Make sure that both shells connect along the full 360° of the shields. No portion of the cabling should be unshielded. Never divide a cable across a terminal strip.

For differential inputs for analog signals, use twisted-pair, shielded signal lines, connecting shields on both ends.

3.4 Electrical System Considerations

3.4.1 Fusing

- US fuses: Class RK5 or CC or J or T, 600 VAC 200 kA, time-delay. The fuse must be UL and CSA listed; UR-recognized is not sufficient.
- EU fuses: Types gRL or gL, 400 V/500 V, time-delay.
- Fuse holders: Standard fuse blocks, or finger-safe fuse holders according to IEC 60529. For example:
    - Bussmann: CH Series modular fuse holders, fuse size 0 to 30A, class J, 3 poles: CH30J3
    - Ferraz: Ultrasafe fuse holders, fuse size 0 to 30A, class J, 3 poles: US3J3I

3.4.2 Leakage Current Considerations

Leakage current via the PE conductor results from the combination of equipment and cable leakage currents. The leakage current frequency pattern comprises a number of frequencies, whereby the residual-current circuit breakers definitively evaluate the 50 Hz current. For this reason, the leakage current cannot be measured using a conventional multimeter.

As a rule of thumb, the following assumption can be made for leakage current on cables, depending on the PWM frequency of the output stage:

- Ileak = n x 20 mA + L x 1 mA/m at 8 kHz PWM frequency at the output stage
- Ileak = n x 20 mA + L x 2 mA/m at a 16 kHz PWM frequency at the outputstage

(where Ileak=leakage current, n=number of drives, L=length of motor cable)

Since the leakage current to PE is greater than 3.5 mA, compliance with IEC61800-5-1 requires that either the PE connection be doubled or a connecting cable with a cross-section greater than10 mm² be used. Use the PE terminal and the PE connection screws to meet this requirement.

3.4.3 Residual Current Protective Device (RCD)

In compliance with standards IEC 60364-4-41 Regulations for Installation and IEC 60204 Electrical Equipment of Machinery, residual current protective devices (RCD) can be used provided the requisite regulations are met.

RCDs which are sensitive to all currents must be used in order to detect any DC fault current.

To protect against direct contact (with motor cables shorter than 5 m), it is recommended that each drive be protected individually using a 30 mA RCD, which is sensitive to all currents.

3.5 Mechanical Installation

3.5.1 Mounting the MSHD

Using the bracket on the back of the MSHD, mount the MSHD on a grounded conductive metal panel. The panel must be sufficiently rigid.

3.5.2 Mounting Multiple Units

When multiple MSHD units are mounted side-by-side within a cabinet or enclosure, the recommended spacing is 10 mm. When mounting units top-tobottom, the recommended spacing is 50 mm for all models.

It is important to maintain an ambient temperature within the enclosure that does not exceed 45°C.

3.6 Electrical Installation

Figure 3-5. MSHD Front Panel Interfaces

3.6.1 Connect Motor

Motor uses interface P2 on all MSHD models.

Connect the motor interface.

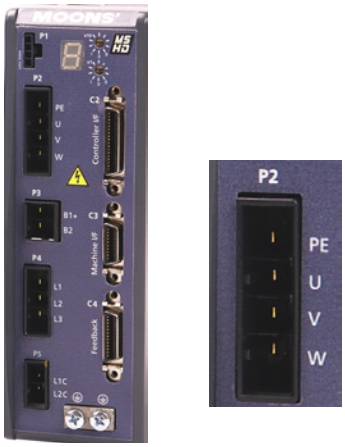


Figure 3-6. Motor Interface

Table 3-1. Motor Interface

Pin	Pin Label	Function
1	PE	Protective ground (motor housing)
2	U	Motor Phase U
3	V	Motor Phase V
4	W	Motor Phase W

Table 3-2. Motor Interface Mating Connector

Item	MSHD-1D5 MSHD-003	MSHD-4D5 MSHD-006	MSHD-008 MSHD-010 MSHD-013
Manufacturer	JST J300	JST J300	JST J400
Housing and 4-pin crimp	F32FSS-04V-KX and SF3F-71GF-P2.0	F32FSS-04V-KX and SF3F-71GF-P2.0	J43FSS-04V-KX and SJ4F-71GF-M3.0
Spring terminal	04JFAT-SBXGF-I	04JFAT-SBXGF-I	Not available
Wire Gauge	16 AWG	14-16 AWG	16 AWG

3.6.2 Connect STO

STO uses interface P1 on all MSHD models.

Safe torque off (STO) is a safety function that prevents the drive from delivering power to the motor, which can generate torque.

STO Enable and STO Return must be connected to enable MSHD operation. The

STO Enable signal voltage must be 24 VDC.

Connect the STO interface.

Note: If the application does not require STO control, jumper pin 4 to pin 1, and pin 3 to pin 2, to bypass the STO.

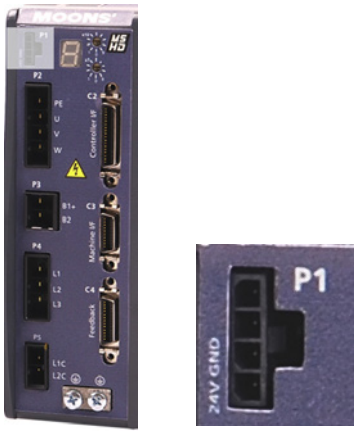


Figure 3-7. STO Interface

Table 3-3. STO Interface

Pin	Pin Label	Function
1	24V	STO Enable
2	GND	STO Return
3		24V Return, provided by the drive for use with emergency stop circuit
4		24V Supply, provided by the drive for use with emergency stop circuit

Table 3-4. STO Interface Mating Connector

Item	All Models
Manufacturer	Molex
Housing and 4-pin crimp	436450400 and 43030-0006
Spring terminal	Not available
Wire Gauge	26–28 AWG

3.6.3 Connect Regen

Regen uses interface P3 on all MSHD models.

Note: On models MSHD-1D5 and MSHD-003, Regen and AC Input Voltage are combined on one connector.

If the application requires a regeneration (regen) resistor, use the P3 interface.

Connect the regen resistor between terminals B1+ and B2.

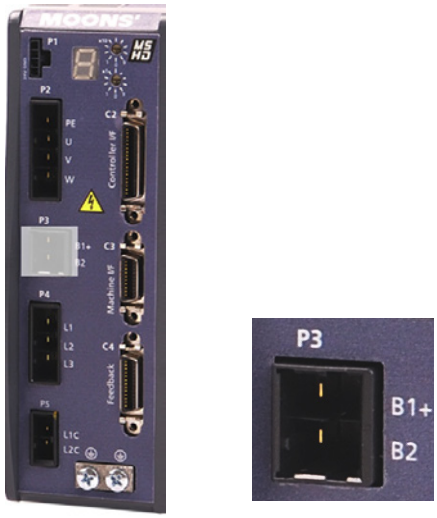


Figure 3-8. Regen Interface

Table 3-5. Regen Interface

Pin	Pin Label	Function
1	B1+	DC bus +
2	B2	Regen bus -

Table 3-6. Regen Interface Mating Connector

Item	MSHD-4D5 MSHD-006	MSHD-008 MSHD-010 MSHD-013
Manufacturer	JST J300	JST J400
Housing and 2-pin crimp	F32FSS-02V-KX and SF3F-71GF-P2.0	J43FSS-02V-KX and SJ4F-71GF-M3.0
Spring terminal	Not available	Not available
Wire Gauge	14-16 AWG	14 AWG

Table 3-7. AC Input Voltage/Regen Interface Mating Connector

Item	MSHD-1D5 MSHD-003
Manufacturer	JST J300
Housing and 4-pin crimp	F32FSS-06V-KX and SF3F-71GF-P2.0
Spring terminal	06JFAT-SBXGF-I
Wire Gauge	16 AWG

3.6.4 Connect Motor Feedback

Connect Motor Feedback

Motor Feedback uses interface C4 on all MSHD models.

Wire the motor feedback interface according to the type of feedback device to be used in your application. Refer to the guidelines following the pinout table below.

Pins 1, 2, 14 and 15 have dual functionality.

Pins 11 and 13 for 5V to the encoder are used in digital board revision 0. Pin 18 can be used only in digital board revision 1 and later.

Pin 25 for the motor temperature sensor is connected internally in the drive to MSHD ground.

Unused pins must remain unwired.

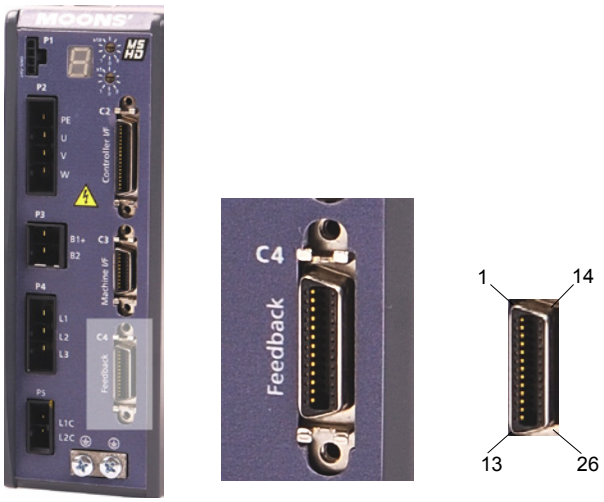


Figure 3-9. Motor Feedback Interface

Table 3-8. Motor Feedback Interface

Pin	Function	Pin	Function
1	Incremental encoder A + or SSI encoder data +	11	5V supply
2	Incremental encoder B + or SSI encoder clock +	12	Motor temperature sensor
3	Incremental Encoder Z +	13	5V supply
4	Hall U +	14	Incremental encoder A - or SSI encoder data -
5	Hall W +	15	Incremental encoder B - or SSI encoder clock -
		16	Incremental encoder Z -
		17	Hall V+
		24	Ground
		25	Motor temperature sensor
		26	Shield

Wiring Guidelines

- For incremental encoder with Halls, use pins 1, 14, 2, 15, 3, 16, 4, 17, 5, 11, 12, 24, 25, 26

3.6.5 Connect Controller I/Os

Controller I/Os uses interface C2 on all MSHD models.

Wire the digital and analog inputs and outputs according to the requirements of your application.

Wire the digital and analog inputs and outputs according to the requirements of your application. Unused pins must remain unwired.

To preserve isolation of the digital I/Os, connect a 24 VDC source to pin 19. Connect the return of the 24 VDC supply to pin 1, which functions as the ground path for the outputs.

Note: The 24 VDC supply and return can be connected on either the Controller interface (C2) or the Machine interface (C3), but it is not necessary to connect it on both.

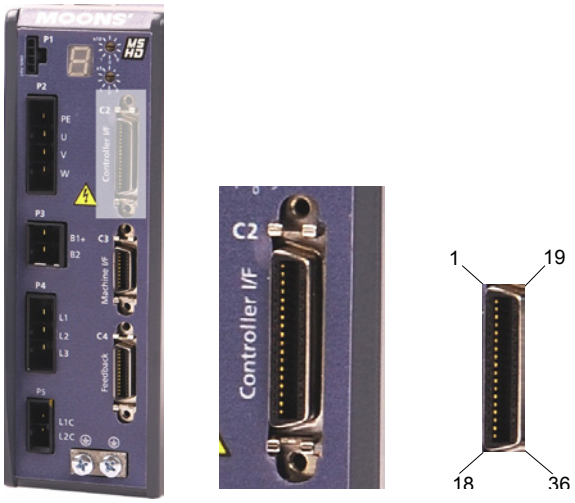


Figure 3-10. Controller I/O Interface

Refer to the controller interface wiring diagram in Figure 2-8.

Table 3-9. Controller I/O Interface

Pin	Function	Description	Pin	Function	Description
1	24 VDC return	Return of the user-supplied 24 VDC	19	24 VDC	User supplied 24V, for I/O biasing
2	Digital output 1	Opto-isolated programmable digital output. Read using OUT1	20	Digital input 2	Opto-isolated programmable digital input. Read using IN2
3	Digital input 1	Opto-isolated programmable digital input. Read using IN1	21		Reserved for future use
4	Equivalent encoder output A-	ALow side of the equivalent encoder output signal (RS422)	22	Equivalent encoder output A+	High side of the equivalent encoder output signal A (RS422)
5	Channel B- out	Low side of the equivalent encoder output signal B (RS422)	23	Channel B+ out	High side of the equivalent encoder output signal B (RS422)
6	Channel Z- out	Low side of the equivalent encoder output index (RS422)	24	Channel Z+ out	High side of the equivalent encoder output index (RS422)
7		Reserved for future use	25	Ground	Digital ground
8	Analog input 1+	High side of the differential analog command input (±10 VDC)	26	Analog input 1-	Low side of the differential analog command input (±10 VDC)
9	Direction input+	High side of the direction signal (RS422), or High side of the master encoder signal B, or High side of the down count signal	27	Direction input-	Low side of the direction signal (RS422), or Low side of the master encoder signal B, or Low side of the down count signal
10	Ground	Digital ground	28	Pulse input+	High side of the pulse signal (RS422), or High side of the master encoder signal A, or High side of the up count signal
11	Pulse input-	Low side of the pulse signal (RS422), or Low side of the master encoder signal A, or Low side of the up count signal	29	Ground	Digital ground
12		Reserved for future use	30		Reserved for future use
13	Ground	Digital ground	31	Digital input 3	Opto-isolated programmable digital input. Read using IN3
14	Digital input 4	Opto-isolated programmable digital input. Read using IN4	32	Digital input 5	Fast opto-isolated programmable digital input. Read using IN5
15	Digital input 6	Fast opto-isolated program-mable digital input. Read using IN6	33	Digital output 2	Opto-isolated programmable digital output. Read using OUT2
16	Digital output 3	Fast opto-isolated program-mable digital output. Read using OUT3	34		Reserved for future use
17		Reserved for future use	35*	Analog input 2-	Low side of the second differential analog input (±10 VDC)
18*	Analog input 2+	High side of the second differential analog input (±10 VDC)	36	Analog output	Analog output, referenced to digital ground (0-10 VDC)

3.6.6 Connect Machine I/Os

Machine I/Os uses interface C3 on all MSHD models.

Wire the machine inputs and outputs according to the requirements of your application.

Unused pins must remain unwired.

To preserve isolation of the digital I/Os, connect a 24 VDC source to pin 9. Connect the return of the 24 VDC supply to pin 19, which functions as the ground path for the outputs.

Note: The 24 VDC supply and return can be connected on either the Controllerinterface (C2) or the Machine interface (C3), but it is not necessary to connect it to both.

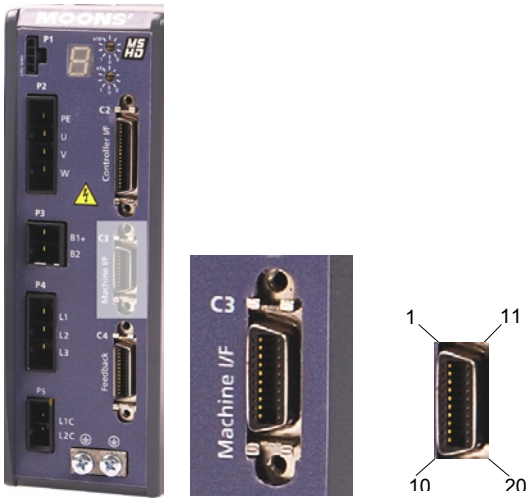


Figure 3-11. Machine I/O Interface

Refer to the machine interface wiring diagram in Figure 2-9.

Table 3-10. Machine I/O Interface

Pin	Function	Description	Pin	Function	Description
1	Secondary encoder A+	High side of the secondary encoder input signal A (RS422), or High side of the pulse signal	11	Secondary encoder A	Low side of the secondary encoder input signal A (RS422), or Low side of the pulse signal
2	Secondary encoder B+	High side of the Secondary encoder input signal B (RS422), or High side of the direction signal	12	Secondary encoder B-	Low side of the secondary encoder input signal B (RS422), or Low side of the direction signal
3	Secondary encoder Z+	High side of the secondary encoder input index (RS422)	13	Secondary encoder Z-	Low side of the secondary encoder input index (RS422)
4	Secondary encoder 5V	5 VDC supply for the secondary encoder	14	Secondary encoder ground	Ground of the 5 VDC supply for the secondary encoder.
5	Digital input 7	Opto-isolated programmable digital input. Read using IN7	15	Digital input 8	Opto-isolated programmable digital input. Read using IN8
6	Digital input 9	Opto-isolated programmable digital input. Read using IN9	16	Digital input 10	Opto-isolated programmable digital input. Read using IN10
7	Digital input 11	Fast opto-isolated programmable digital input. Read using IN11	17	Digital output 4	Opto-isolated programmable digital output. Read using OUT4

8	Digital	Opto-isolated programmable digital output. Read using OUT5	18	Digital output 6	Fast opto-isolated programmable digital output. Read using OUT6
9	output 5	User supplied 24V, for I/O biasing	19	24 VDC return	Return of the usersupplied 24 VDC
10	Fault relay 1	Terminal 1 of the dry contact fault relay	20	Fault relay 2	Terminal 2 of the dry contact fault relay

3.6.7 Connect AC Input Voltage

Note: The AC Input interfaces and connectors vary among MSHD models.

- MSHD-1D5 and MSHD-003: One connector for bus power and logic power uses interface P3.
- MSHD-006: One connector for bus power and logic power uses interface P4.
- MSHD-013: Two connectors – a connector for bus power uses interface P4, and another connector for logic power uses interface P5.

Make the following connections:

1. Connect L1, L2 and L3 (for bus power).
    - If the main voltage is from a single-phase source, connect line and neutral to L1 and L2.
    - If the main voltage is from a three-phase source, connect the phases to L1, L2 and L3.
2. Connect the AC input voltage ground wire to the PE terminal, located on the MSHD front panel. Use an M4 ring or spade terminal.

Figure 3-12. Ground Terminals

3. Connect L1C and L2C (for logic power).
    - If the main voltage is from a single-phase source, connect line and neutral to L1C and L2C.
    - If the main voltage is from a three-phase source, connect any two phases to L1C and L2C.

Make sure the main voltage rating matches the drive specification. Applying incorrect voltage may cause drive failure.

Make sure that the AC supply for the main power input (L1 and L2), and the logic power input (L1C and L2C) are from the same AC phase input, as shown in Figure 3-2.

Do not apply power until all hardware connections are complete.

Note: On models MSHD-1D5 and MSHD-003, Regen and AC Input Voltage are combined on one connector. Since these models support only singlephase AC, they do not have a L3 terminal for bus power.

Table 3-11. AC Input Voltage

MSHD-1D5 MSHD-003	Pin	Pin Label	Function
P3	3	L1	AC Phase 1
	4	L2	AC Phase 2
	5	L1C	Logic AC Phase 1
	6	LC2	Logic AC Neutral
MSHD-4D5 MSHD-006	**Pin**	**Pin Label**	**Function**
P4	1	L1	AC Phase 1
	2	L2	AC Phase 2
	3	L3	AC Phase 3
	4	L1C	Logic AC Phase 1
	5	LC2	Logic AC Neutral
MSHD-008 MSHD-010 MSHD-013	**Pin**	**Pin Label**	**Function**
P4	1	L1	AC Phase 1
	2	L2	AC Phase 2
	3	L3	AC Phase 3
P5	1	L1C	Logic AC Phase 1
	2	LC2	Logic AC Neutral

Table 3-12. AC Input Voltage Interface Mating Connector

Item	MSHD-1D5/MSHD-003
Manufacturer	JST J300
Housing and 6-pin crimp (includes Regen)	F32FSS-06V-KX andSF3F-71GF-P2.0
Spring terminal	06JFAT-SBXGF-I
Wire Gauge	16 AWG
	MSHD-4D5/MSHD-006
Manufacturer	JST J300
Housing and 5-pin crimp	F32FSS-05V-KX and SF3F71-GF-P2.0
Spring terminal	05JFAT-SBXGF-I
Wire Gauge	14–16 AWG
	MSHD-008/MSHD-010/ MSHD-013
Manufacturer	JST J400
Housing and 3-pin crimp	F32FSS-03V-KX and SJ4F-71GF-M3.0
Spring terminal	Not available
Wire Gauge	14 AWG
Manufacturer	JST J300
Housing and 2-pin crimp	F32FSS-02V-KX and SF3F-71GF-P2.0
Spring terminal	Not available
Wire Gauge	16 AWG

3.7 Set the Drive Address

The MSHD has two 10-position rotary switches, accessible from the front of the unit. The switches are used to set the drive address. When there is more than one drive on a daisy-chain or CANbus network, each drive must have a unique address to enable its identification on the network.

Use the two rotary switches to set the drive address for both CAN and serial communication.

For Ethernet-based motion buses, the switch has no functional use for either the drive or the network. It can be used at the application level to identify specific drives on a network.

Each switch has 10 positions:

- The upper switch positions are set as tens: 10, 20, 30 … 90
- The lower switch positions are set as ones: 0, 1, 2 … 9

Note: If two or more drives are connected to the network, address 0 cannot be used. A singular drive may have the address 0.

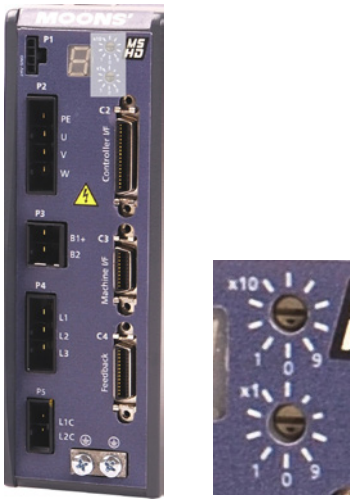


Figure 3-13. Drive Address Rotary Switches

3.8 Connect to PC

To connect the drive to the host computer, use either one of the following interfaces:

- USB port. The interface is labeled C1 on all MSHD models. Use a USB 2.0 A to Mini-B cable.

Figure 3-14. USB Port

The first time the drive is connected to the host computer on the USB port, Windows will detect the device and display a Found New Hardware wizard.

Refer to the section Power Up.

- RS232 port. The interface is labeled C7 on all MSHD models.

Use a 4p4c plug.

Figure 3-15. RS232 Port

Table 3-13. RS232 Interface

Pin	Pin Label	Function
1	RX	Receive
2	GND ISO	Ground
3	TX	Transmit
4		Unused

3.9 ServoStudio Software Installation

1. Install ServoStudio software on the host computer.
2. When installation is complete, start ServoStudio from the Windows Start menu or the shortcut on your desktop.

3.10 Power Up

1. After completing the hardware connections, turn on power to the drive.

Note: If logic and bus AC supplies are separate, it is recommended that logic AC be turned on before bus AC.

2. The first time the drive is connected to the host computer on the USB port, Windows detects the device and displays a Found New Hardware wizard.

Browse to and select the Drivers folder. The path will vary, depending on the computer's operating system and the location selected for software installation; for example:

- \Program Files (x86)\\ServoStudio\Drivers
- \Program Files\\ServoStudio\Drivers

The wizard will automatically select and install the driver file STX-MSHD.inf from the folder.

3. Look at the 7-segment display on the MSHD front panel.

   Upon initial power up, the status display shows a flashing e, indicating a Parameter Memory Checksum Failure. This fault will be cleared once the drive is configured and the parameters are saved in the drive's non-volatile memory.

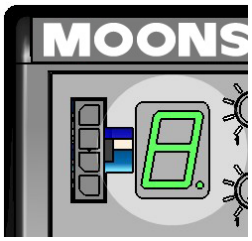


Figure 3-16. 7-Segment LED Status Display

The digital display provides various indications of drive operation, such as operation modes, drive enable status, and fault conditions.

For more information, refer to the section Drive Status 7-Segment Display.

4 ServoStudio

4.1 Overview

ServoStudio is a graphic user interface (GUI) provided with the MSHD to enable setup, configuration and tuning of the drive.

ServoStudio allows you to program the drive parameters specifically for the motor to which the MSHD is connected, and for the particular operation that the drive will be performing in the machine.

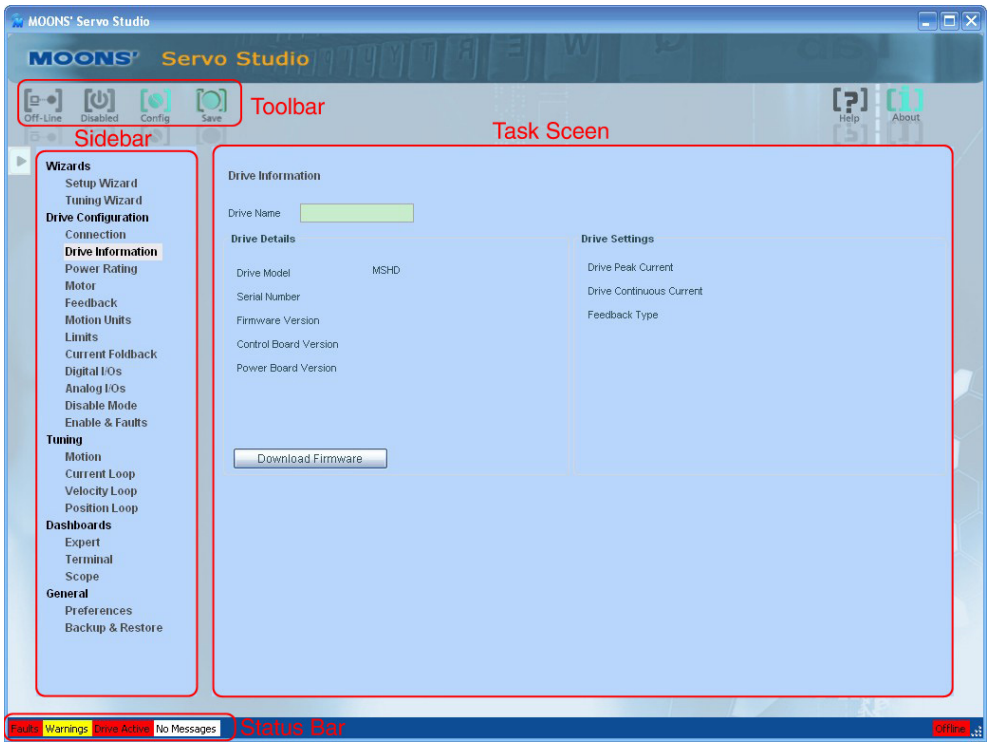


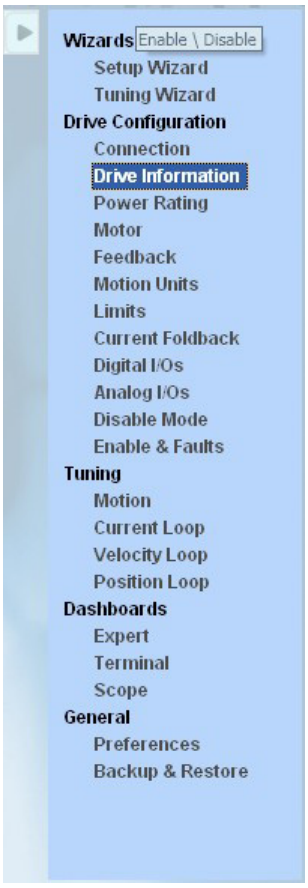
Figure 4-1. ServoStudio Software

ServoStudio provides two primary ways for setting up the MSHD servo drive.

- Using the Setup Wizard, which takes you step-by-step through the basic configuration process. The Tuning Wizard can be used after the basic configuration is completed, to tune the non-linear position control loop.
- Using each setup screen individually, to access and define specific drive functions.

4.1.1 Interface Elements

The ServoStudio application has four function areas:

Toolbar	Contains quick access buttons for frequently used functions. **Configuration** – Triggers the internal drive configuration. The CONFIG command is required after certain variables are modified. Refer to VarCom CONFIG. When the 7-digit display shows -1, CONFIG is required. **Enable|Disable** – Enables and disables the drive, and indicates the state of the drive. Refer to the section Enabling the Drive. Refer also to VarCom EN and VarCom K. **Offline|Online** – Toggles the drive between online and offline states, and indicates the state of the drive. Refer to the section Connecting to the Drive. **Save** – Saves the parameters currently displayed on screen to non-volatile memory. Refer to the section Managing Parameters.
Sidebar	Contains a navigation menu to the various ServoStudio screens. The sidebar can be hidden or displayed using the Arrow button. 

Task Screen	Displays various interactive screens for viewing, setting and testing parameters and drive configurations. These screens are described in detail in other sections throughout this manual.
Status Bar	 Displays the status of the drive. • **Progress bar.** Some tasks may take more than a few seconds to execute, such as connecting to the drive; if so, a green bar shows the progress of the action. • **Faults.** This segment of the status bar is green as long as no faults exist; it is red whenever a fault exists. Click Faults to open the Enable & Faults screen. • **Warnings.** This segment of the status bar is green as long as no warnings exist; it is yellow whenever a warning exists. Click Warnings to open the Enable & Faults screen. • **Messages.** Notifications from ServoStudio that do not require immediate attention. They are saved and displayed upon request; you can continue normal work without viewing them. Click Messages to see the full text. For more information about warnings and faults, refer to the chapter Troubleshooting.

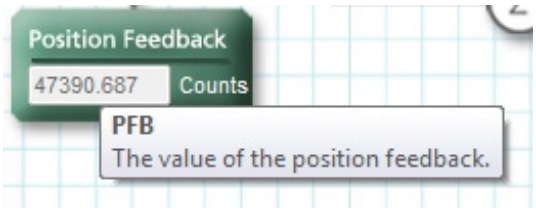
4.1.2 Schematic Diagrams

ServoStudio uses schematic diagrams in many of the configuration and tuning screens to help you visualize and correctly set values for required parameters.

Some of the fields in these screens are read-only. Their values are entered automatically according to the motor defined in the Motor screen and/or settings defined elsewhere in the software.

Other fields in these schematic screen are configurable (read/write). After entering or modifying a value, press Enter to send the value to the drive. For more information about working with configurable fields, refer to the section Parameter Values.

Hover over a parameter field to view its description and VarCom equivalent.



4.1.3 Parameter Values

Throughout ServoStudio, you will work with fields containing configurable (read/write) drive parameters.

Whenever you begin entering a parameter value, the field turns blue.

Once you press Enter, the value in the field is sent to drive.

- If the value entered is valid, the field reverts to white. The displayed format of the value might be slightly different than what you entered; for example, if you enter 10, the drive might return 10.00.
- If the value entered is invalid, the field turns red.

Fields that are gray are read-only. Their values cannot be modified.

Press F1 when a parameter field is selected to open the Help file for the parameter.

4.2 Dashboards

ServoStudio has several dashboards. These screens contain a combination of function panes, which allow you to work more efficiently.

4.2.1 Terminal

The Terminal screen allows you to send VarCom instructions to the drive, and read the drive's responses. It also includes a Watch panel that allows you to monitor parameters.

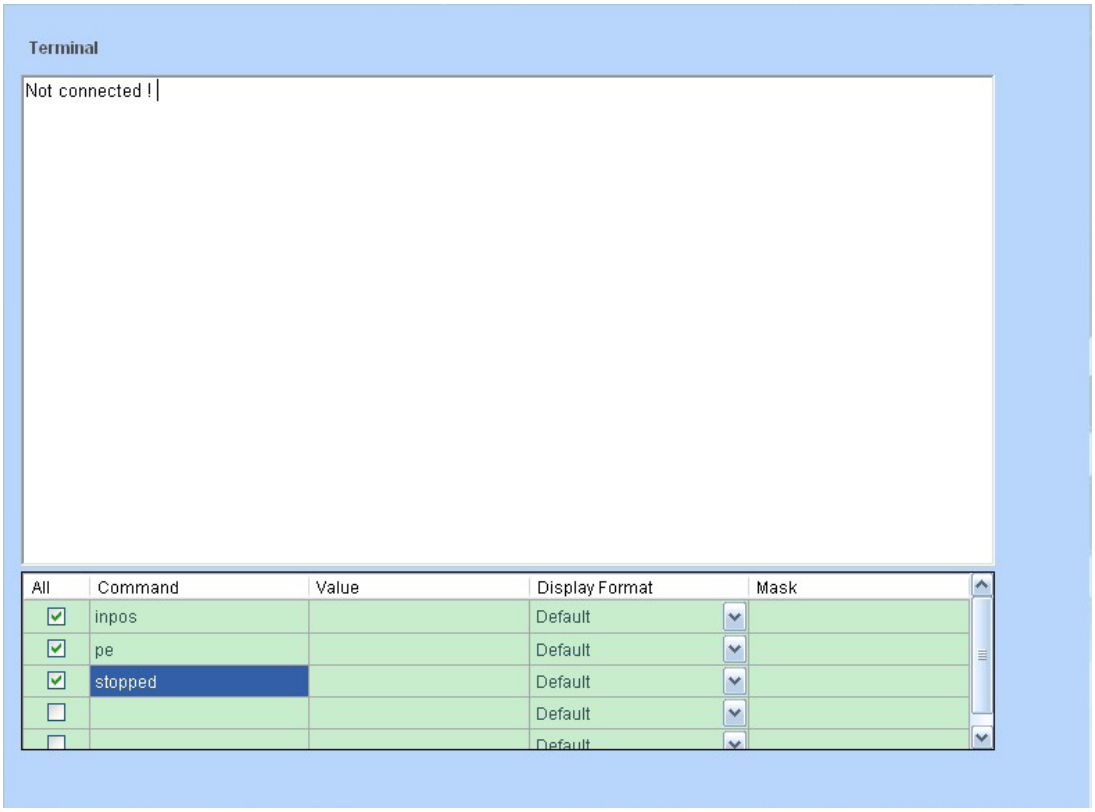


Figure 4-3. ServoStudio – Terminal Dashboard

ServoStudio provides two methods that reduce the need for command memorization and keyboard input:

- Autocompletion: An autocompletion system (IntelliSense) allows you to access commands and descriptions of their functions. IntelliSense can be disabled in the Preferences screen.

  When you begin typing a command, a list of available drive commands is displayed based on the characters typed.

- History: Use the Up arrow key to show a list of all command strings that have been sent to drive in the present session (i.e., since ServoStudio was last opened).

When a command in the autocomplete or history list is highlighted:

- Press Enter to sends the command to drive.
- Press spacebar to edit the command. Right-click anywhere in the Terminal panel to access two additional functions:
- Clear Terminal: Deletes the contents of the Terminal.
- Save to File: Prompts you to save the contents as a text file.

Watch Panel

The Watch panel is used to monitor drive variables. The rate at which variables are updated is dependent on the load on the serial communications link and on the Refresh Rate of Data From Drive setting in the Preferences screen.

All	Select or clear an individual checkbox to start or stop monitoring a specific variable. Click the header All to select or clear all variables listed.
Command	Use this field to enter the name of the drive variable whose value you want to monitor. Click the header Command to sort the list alphabetically. Once alphabetized, click the header to reverse ascending/ descending order.
Value	The value of the watched variable is displayed in this field.
Display Format	Select the format that is used for displaying the value: default, Binary Decimal or Hexadecimal.
Mask	Use this field to enter a value that will be logically ANDed with the parameter value.

4.2.2 Scope

The Scope screen enables you to configure recording settings, record data from the drive, and display the data according to your preferences. It also allows you to generate motion in order to record data related to that specific motion. Commands can be sent to the drive via the Terminal tab.

Refer to the section Non-Linear Position Control Loop for detailed information.

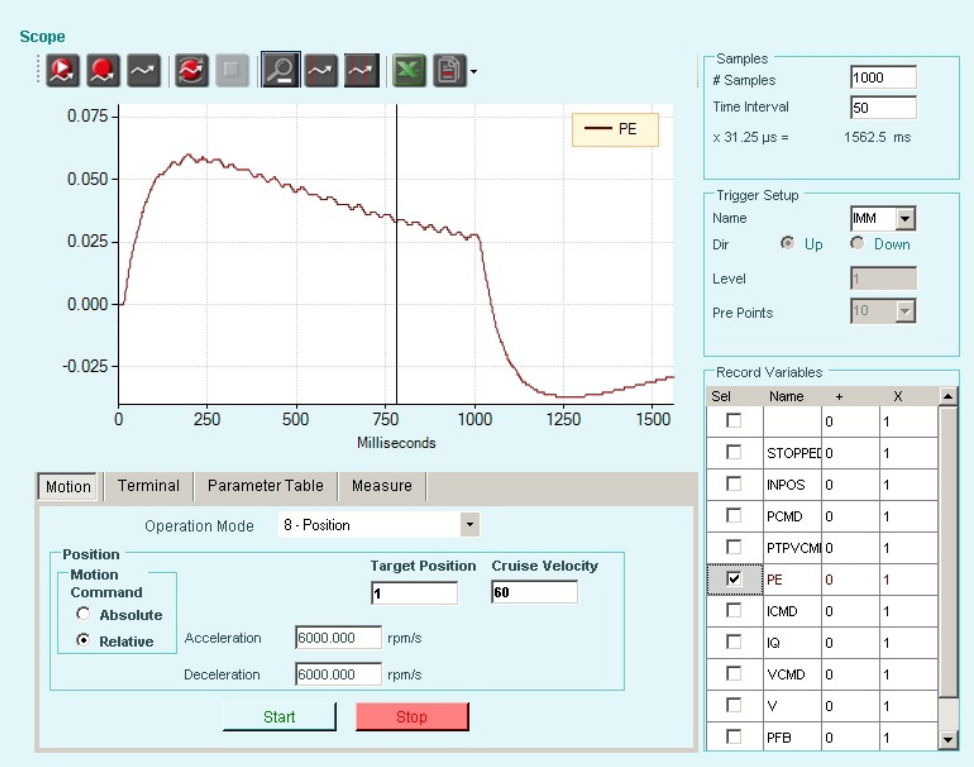


Figure 4-4. ServoStudio – Scope Dashboard

4.2.3 Expert

The Expert screen allows you to perform the following tasks:

- Send commands to the drive using the Terminal panel.
- Change operation mode and initiate motion using the Motion panel.
- Monitor parameters using the Watch panel.
- Set recording properties using the ScopeChart panel.
- Program and run scripts using the Script panel.

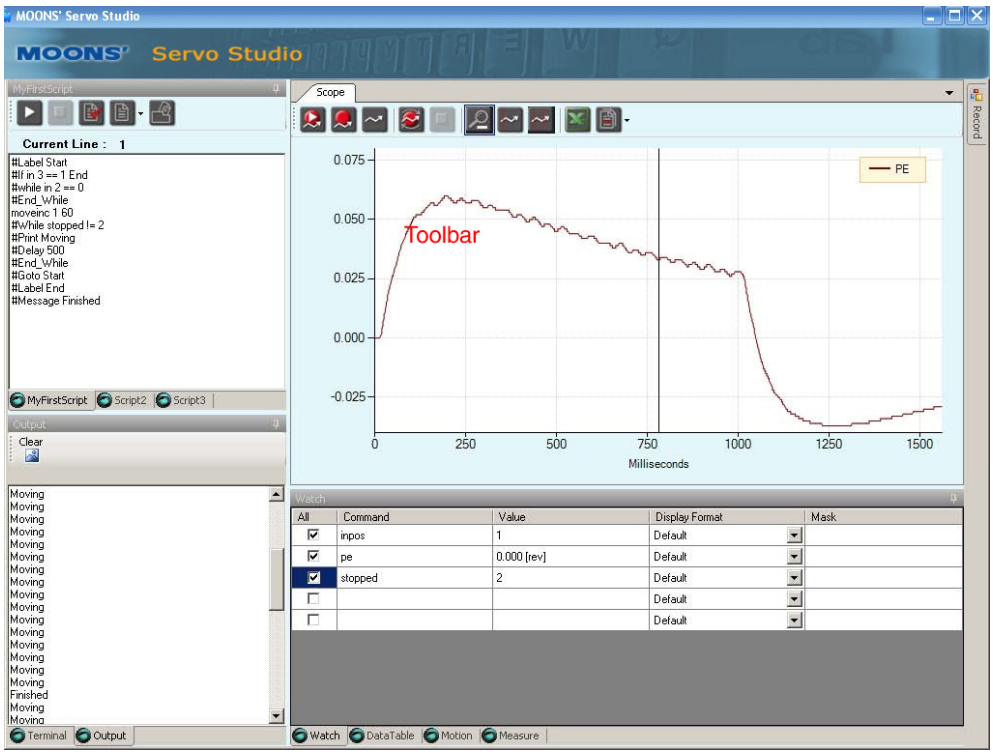
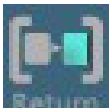


Figure 4-5. ServoStudio – Expert Dashboard

The Expert toolbar has two additional buttons:

	Restore – Resets the Expert screen to the default layout.
	**Return** – Closes the Expert screen and reopens the standard ServoStudio interface. Alternately, use the X at the top right for the Return function.

The Expert screen has dockable panels, which can be visible, hidden or floating.

	Click to autohide the panel to the edge of the screen. Small tab/s remain visible. Hovering over the tabs opens the panel.
	Indicates the panel is hidden. Click to keep the panel visible.

Double-click the top border of a panel to make it float. Double-click again to re-dock a floating panel.

Alternately, click the top border of a panel and drag it to any location on the desktop. If a panel has been dragged to a floating position, it must be dragged back into position. Clicking its top border causes it to close.

To restore the default layout of panels in Expert Studio, use the Restore button on the Expert View toolbar.

To save a personalized layout of panels in Expert Studio, do the following:

- From the ScopeChart toobar, open the Chart Options menu, or right-click anywhere in the ScopeChart panel.

- Select Windows Layout > Save Layout.

  To load a saved personalized layout of panels in Expert Studio, do the following:

- From the ScopeChart toobar, open the Chart Options menu, or right-click anywhere in the ScopeChart panel.
- Select Windows Layout > Load Layout.

[Terminal | Output] Panel

Terminal Tab

Refer to the section Terminal.

Output Tab

The Output tab shows data generated by the #Print command in a script.

Scope Panel

Refer to the section Data Recording.

[Watch | Motion | Measure] Panel

Watch Tab

Refer to the section Watch Panel.

Motion Tab

Refer to the section Operation Modes.

Measure Tab

Refer to the section Scope.

Script Panel

ServoStudio includes a simple scripting language that allows the MSHD to perform logical and control tasks that can run independently. Such tasks include:

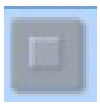
- Send commands to the drive.
- Read and set values in the drive.
- Define variables and perform simple operations on their values.
- Issue commands according to status or conditions.
- Control program flow.
- Plot recorded data
- Save and restore drive parameters.

The scripting language, commands and syntax are described fully in Appendix: Scripting.

Script Tab

Each script opens in its own tab. Any number of scripts can be open and in use.

The Script tab includes a toolbar with a number of buttons:

	Run – Validates and then runs a script.
	**Stop** – Halts a running script.
	Validate – Checks the syntax of a script to make sure all script commands are valid. Highlights any errors. It does not check the validity of MSHD VarCom instructions.
	File – Click the arrow to access the file options: • Open – Opens a saved script file. Also Ctrl+O • Save – Saves the script to a file. Also Ctrl+S • Save As – Saves the script under a different filename. • Dump – Retrieves all parameters from drive memory. Can be used for viewing and modifying parameter values, followed by Run to send new values to drive. Refer to VarCom DUMP. • Copy – Ctrl+C • Paste – Same as Ctrl+V • Clean Script – Selects and deletes all contents of script tab. • Close Script – Closes script without saving contents. Script file options can also be accessed by right-clicking anywhere in a Script tab.
	New Script – Opens a new tab for a new script.

ServoStudio provides two methods that reduce the need for command memorization and keyboard input:

- Autocompletion: An autocompletion system (IntelliSense) allows you to access commands and descriptions of their functions. IntelliSense can be disabled in the Preferences screen.

  When you begin typing a command, a list of available drive commands is displayed based on the characters typed.
- History: Use the Up arrow key to show a list of all command strings that have been sent to drive in the present session (i.e., since ServoStudio was last opened).

  When a command in the autocomplete or history list is highlighted:
- Press Enter to sends the command to drive.
- Press spacebar to edit the command.

4.3 Wizards

ServoStudio includes two wizards, or interactive utilities, that guide you through complex tasks.

4.3.1 Setup

The Setup Wizard takes you step-by-step through the most basic setup and configuration process.

Refer to the section Setup Wizard.

4.3.2 Tuning

The Tuning Wizard takes you through a procedure to autotune the various control loops.

Refer to the section Tuning Wizard.

4.4 Preferences

The Preferences screen allows you to modify file names and locations, runtime options, and other ServoStudio default settings.

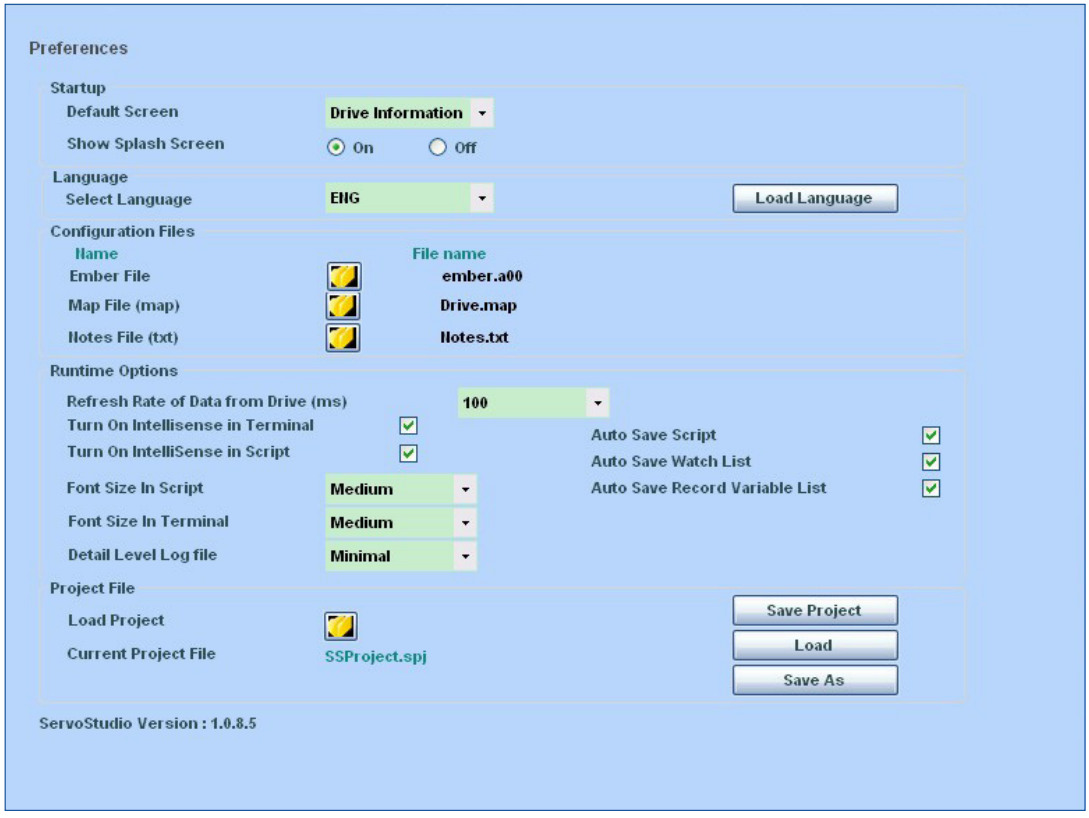


Figure 4-6. ServoStudio – Preferences Screen

Startup	**Default Screen** – The task screen that is displayed when ServoStudio is activated. It can be any of the screens listed in the sidebar. By default, Drive Information is the default screen. **Show Splash Screen** – Defines whether the ServoStudio splash screen is displayed when ServoStudio is activated.
Configuration Files	The names and locations of files used by ServoStudio. For Expert users only.
Runtime Options	**Refresh Rate of Data from Drive** – Sets the rate at which variable values are refreshed on screen. This includes both user-defined watched variables and system-defined variables which may trigger warnings or faults. Defined in milliseconds. Refer to the section Watch Panel. **Turn On IntelliSense in Terminal:** Activates autoselection and complete when working in Terminal panel. Opens and displays list of available drive commands that can be selected based on the characters entered. **Turn on IntelliSense in Script** – Activates autoselection and complete when working in Script panel. Opens and displays list of available drive commands that can be selected based on the characters entered. **Auto Save options** – For Expert users. Selected elements will be automatically saved and restored the next time ServoStudio is opened, even if they were not explicitly saved before closing ServoStudio. **Font Size** – Defines the size of the text displayed in the Script and Terminal panels.
Project File	A project file contains all settings currently defined in ServoStudio, and any autosaved data.
ServoStudio Version	The version of the ServoStudio software.

5 Configuration

5.1 Introduction

This section presents the main concepts and functions related to theconfiguration and operation of the MSHD drive.

5.1.1 Configuration Parameters

Drive functionality is configured using various commands and variables, which are transmitted over the communication bus. The terms variables and parameters are used interchangeably; drive parameter set refers to the set of variables that are specifically defined for a particular application.

Commands and variables are identified by a mnemonic (VarCom) name. For example, MPOLES is the mnemonic used to read and write the setting for the number of motor poles.

VarCom instructions, which are used with serial communications, are detailed in the MSHD VarCom Reference Manual.

Some variables are read-only, while others allow read/write access. Variables can be stored in the MSHD's non-volatile (flash) memory for use at each powerup.

In general, drives are shipped from the factory with motor parameters set to zero and application parameters set to their default values.

5.1.2 Managing Parameters

Drive Memory

The MSHD drive has two types of memory for storing the drive's parameters:

- Flash: Non-volatile memory. It holds the drive's default parameter values (contained within the drive's firmware), as well as the saved set of parameters.
- RAM: Volatile memory. The drive's working memory. Parameter values are maintained in RAM while you configure and test the drive and adjust parameters. If power to the drive is disconnected, any unsaved changes in the parameters will be lost.

During power up, the MSHD loads parameter values from the non-volatile memory to RAM, and a checksum of these parameter values is calculated. If the checksum is invalid, default parameter values (which are hard-coded in the drive's firmware) are loaded into RAM and a Parameter Memory Checksum Failure fault is set.

The following diagram illustrates the relationships among the different types of memory and commands used for managing the drive parameters.

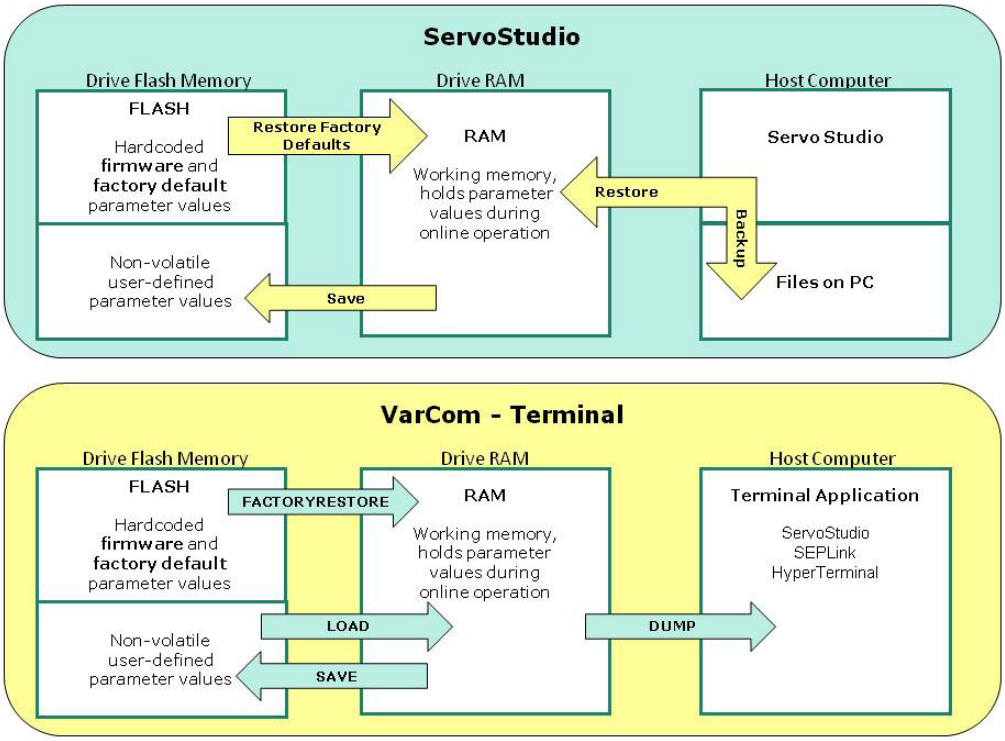


Figure 5-1. Memory and Commands for Managing Parameters

In ServoStudio, drive parameters may be saved to non-volatile memory at any time by clicking on the Save button on the toolbar.

Backup & Restore

The Backup & Restore screen allows you to save and load parameters to and from files on the host computer.

Figure 5-2. ServoStudio - Backup & Restore Screen

Backup	Opens a Save as dialog box. Writes parameters from the drive RAM to a file on the PC. The parameters are saved in a text file with either TXT or SSV extension. The text file can be edited using Notepad or any other text editor.
Restore	Opens an Open dialog box. Loads parameters from a file on the PC to the drive RAM.

A Parameter Table appears in various ServoStudio screens, such as Scope and Motor. It displays a list of values relevant to the task screen or operation mode in effect.

For each parameter, the tables displays the present value in the drive working memory, and allows you to modify the value.

The tooltip on the parameter Name shows the corresponding VarCom mnemonic.

Refer to VarCom SAVE, LOAD and RESTOREDEFAULTS.

5.1.3 Enabling the Drive

Caution: Enabling the drive might cause the motor to move.

Three conditions are required for enabling the MSHD drive:

- **No faults**
- The **Software Enable** switch must be on. The commands EN (Enable) and K (Disable) toggle the state of Software Enable. The Enable|Disable button on the toolbar also toggles the Software Enable switch.
- The **Remote Enable** signal must be on. This signal is controlled by one of the digital inputs in the Controller I/O connector. If no input is configured for this function, the Remote Enable signal remains on, and the drive can be enabled and disabled solely by the commands EN (Enable) and K (Disable).

The following elements provide visual indications of the drive's Enabled or Disabled status:

	The Enable|Disable button in the ServoStudio toolbar indicates the state of the drive. • If lit, the drive is enabled (active). Power is being applied to the motor. • If unlit, the drive is disabled.
	The decimal point (.) on the drive's 7-segment display indicates the drive's Enable/Disable state. If the point is displayed next to the OPMODE code, the drive is enabled.

The ServoStudio Enable & Faults screen graphically shows the conditions required for the drive to be enabled. It allows you to clear faults and turn on Software Enable.

For more information about enabling and disabling the drive, refer to the section Enable/Disable.

5.2 Drive Configuration Sequence

Disable the drive before manipulating motor and feedback parameters.

Many parameters can be modified while the drive is enabled. Exercise caution, however, as motor behavior will change.

If a parameter cannot be modified while the drive is enabled, ServoStudio will prompt you to disable the drive.

Important:

It is recommended that you perform the drive configuration according to the sequence shown in Figure 5-3. Refer to the notes that follow.

While setting parameters, pay close attention to any warning or error messages that appear in ServoStudio, and any flashing codes on the drive itself.

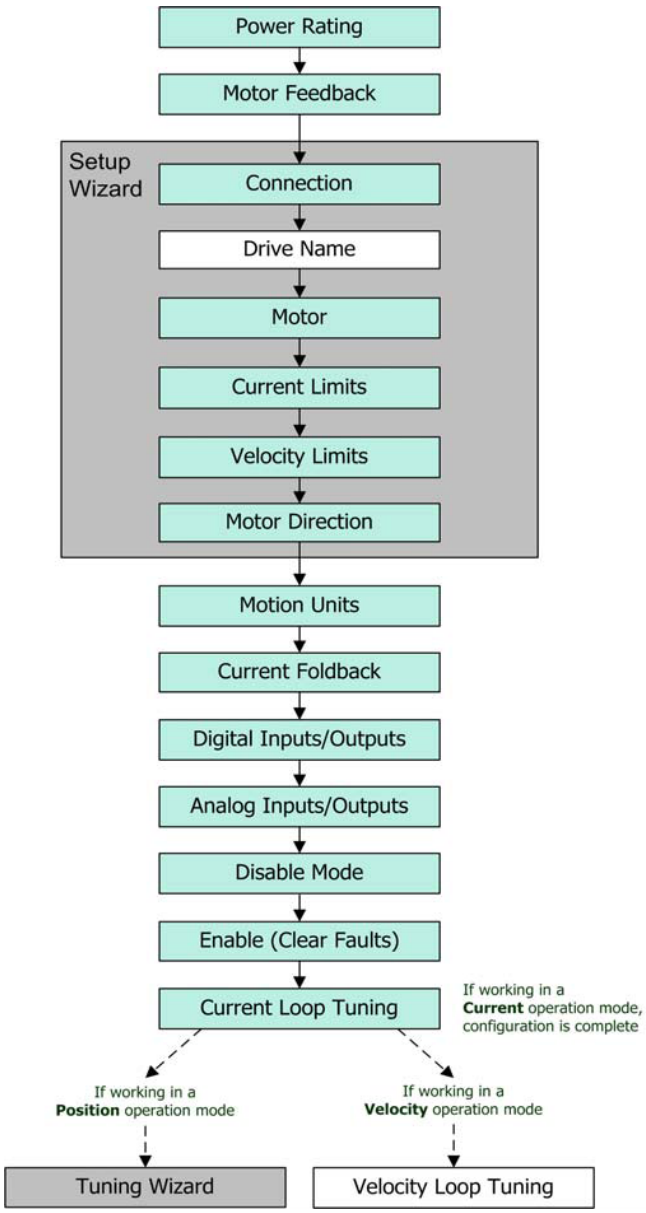


Figure 5-3. Recommended Sequence for Drive Configuration

Notes for Configuration Sequence:

Power Rating	The Setup Wizard assumes the bus voltage setting is 320. If the drive is being powered by 220 VAC per phase, you can skip this step. If the drive is being powered by 110 VAC per phase, you must change the setting to 160. Refer to the section Power Rating.
Motor Feedback	The Setup Wizard assumes that the motor model number indicates a particular type of feedback. If this is not true for your motor, you must define the motor feedback before starting the Setup Wizard. Refer to the section Motor Feedback.
Connection	Refer to the section Connecting to the Drive.
Drive Name	Optional. Refer to the section Drive Information.
Motor	The Setup Wizard configures the motor phasing. See note for Motor Feedback, above. Refer to the section Motor.
Current Limits	The Setup Wizard suggests values for low, medium or high current limits; user-defined values can also be entered. Refer to the section Current Limits.
Velocity Limits	The Setup Wizard suggests values for low, medium or high current limits; user-defined values can also be entered. Refer to the section Velocity Limits.
Motor Direction	The Setup Wizard simplifies the defining of rotation direction for a positive command. Otherwise, VarCom instructions are required. Refer to the section Motor Direction.
Motion Units	Refer to the section Motion Units.
Current Foldback	Refer to the section Foldback.
Digital Inputs/Outputs	Refer to the section Digital I/Os.
Analog Inputs/Outputs	Refer to the section Analog I/Os
Enable	Needed for clearing faults. Refer to the section Enable/Disable.
Current Loop Tuning	The Setup Wizard tunes the Current Control Loop at a basic level. This is sufficient for proceeding to Tuning Wizard. To achieve optimal performance, use the Current Loop Tuning option in the Current Loop screen. Refer to the section Current Control Loop.
Velocity Loop Tuning	Optional. Refer to the section Velocity Control Loop.
Tuning Wizard	Refer to the section Tuning Wizard.

5.3 Setup Wizard

The Setup Wizard provides the quickest and easiest method for getting the drive up and running. It configures only the essential parameters.

It is recommended that you use the ServoStudio Setup Wizard when connecting the drive for the first time.

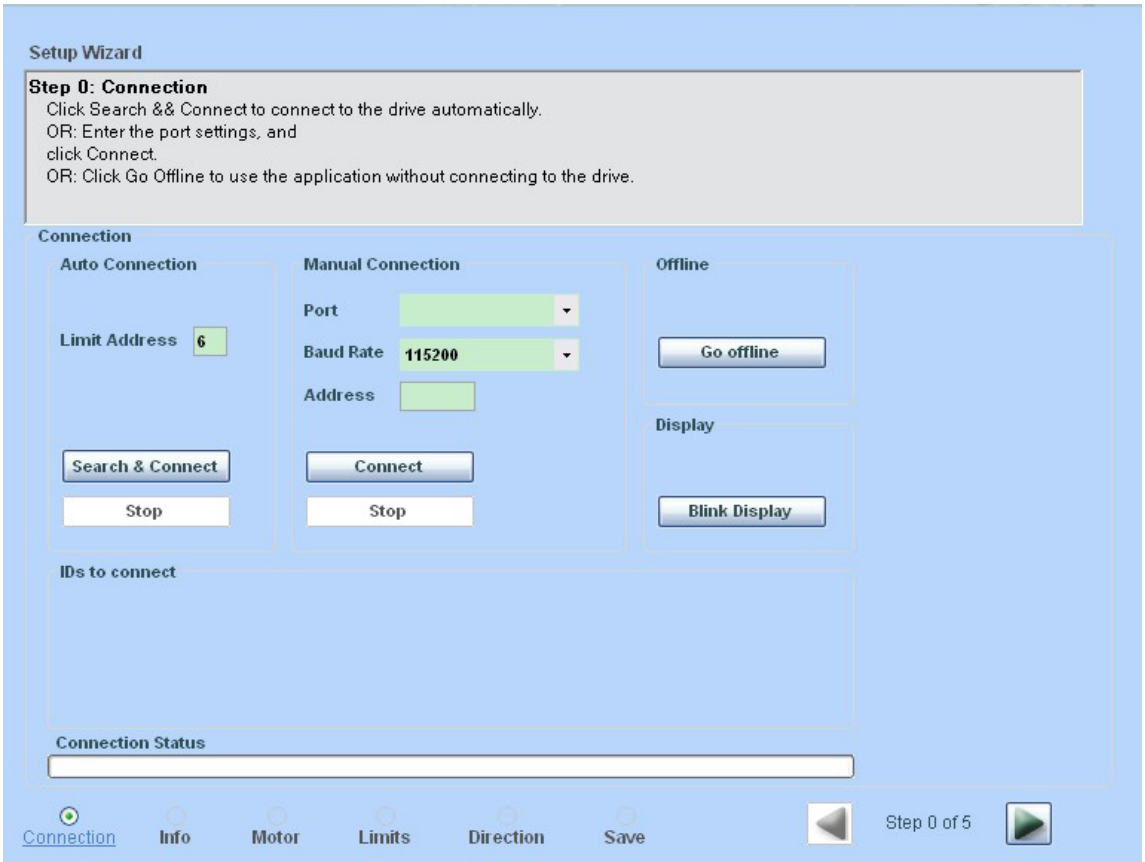


Figure 5-4. ServoStudio - Setup Wizard Screen

Step 0: Connection

Note: Typically, the Wizard begins at Step 0. If the drive is already connected, the Wizard will begin at Step 1.

To connect to the drive, do one of the following:

- Click Search & Connect to connect to the drive automatically.
- Enter the port settings, and click Connect.

For more information, refer to the section Connecting to the Drive.

Step 1: Drive Information

1. Review the drive information.
2. Enter a name for the drive.

For more information, refer to the section Drive Information.

Step 2: Motor Selection

1. Select the Motor Family
2. Select the Motor Type.

3. Select the characters that match the label on the motor (# means the field can be ignored).
4. Click Verify to send parameters to the drive and test the motor configuration.

Verify enables the drive and moves the motor!

For more information, refer to the section Motor.

Step 3: Velocity and Current Limits

Setup Wizard suggests values for Low, Medium or High current and velocity limits, which are rounded to 25%, 50% and 75%, respectively, of the maximum range.

Note: If the limits are set too low, the Tuning Wizard might not produce the optimal result.

1. Do either of the following to set velocity and current limits:

- Select the suggested Low, Medium or High values.
- Select User Defined, and enter your preferred values.

2. Click Approve to send the values to the drive.

For more information, refer to the sections Current Limits and Velocity Limits.

Step 4: Move and Set Direction

The Setup Wizard simplifies the process of defining the rotation direction for a positive command. Otherwise, VarCom instructions are required. For more information, refer to the section Motor Direction and to VarCom MPHASE and DIR.

1. To verify motor motion direction, click Left or Right.

Left and Right enable the drive and move the motor!

2. To reverse the direction to match your system, click Inverse Direction.
3. To continue, click Approve Direction.

Step 5: Save

It is recommended that you save parameters to the drive's non-volative memory and to a file on the host computer for backup.

1. Click Save to Drive.
2. Click Save to File.

Next Step

Once the Setup Wizard is completed, the Current control loop is configured at a basic level.

You are prompted to press the Next arrow to continue to the Tuning Wizard.

It is recommended, however, that you first complete the configuration sequence, as shown in Figure 5-3. This includes tuning the drive for optimal performance in a Current control loop by means of the Current Loop Tuning option in the Current Loop screen.

You can then do either of the following:

- Tune the drive for operation in a Position control loop, using the Tuning Wizard.
- Tune the drive for operation in a Velocity control loop, using the Velocity Loop screen.

5.4 Connecting to the Drive

From the ServoStudio navigation sidebar, click Connection.
The Connection screen is now displayed in the task area.

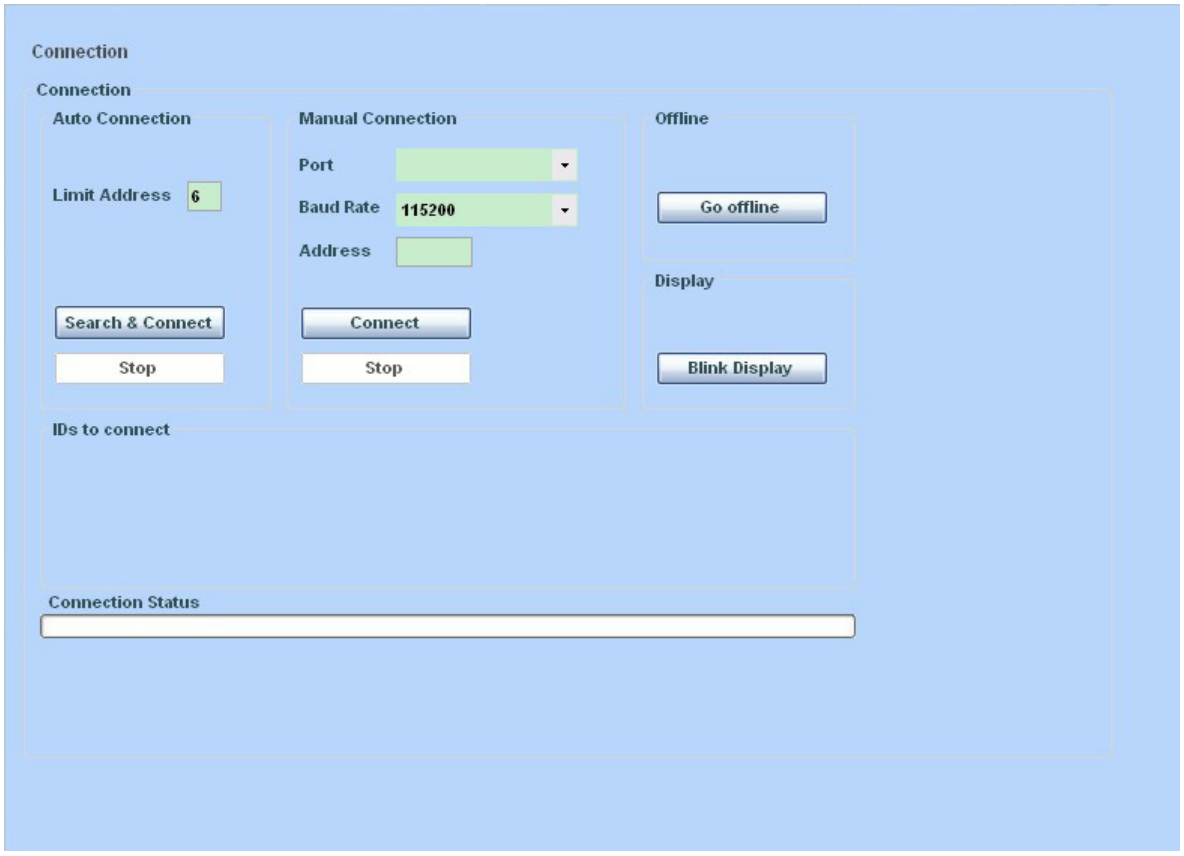


Figure 5-5. ServoStudio - Connection Screen

The Connection screen includes a Offline option. In addition, the ServoStudio toolbar has an Online|Offline toggle button.

- Offline mode: ServoStudio does not attempt to communicate with the drive.
- Online mode: ServoStudio continually communicates with the drive to read parameters and status.

Note: It is recommended to switch to Offline mode before physically disconnecting the drive or powering off the drive.

To use ServoStudio without connecting to the motor, click Go Offline.

To connect to the drive, use either of the following options:

- Auto Connection. Click Search & Connect.

The software searches all COM ports on the host computer to locate the port to which a drive is connected.

Once the software identifies the port, it searches for all drives that may be daisy-chained to the port. Since this search can take a long time, the Limit Address option allows you to define the number of addresses, from 0-99 to be searched. By default, the limit is set to 5 addresses.

The names and addresses of all drives found will be listed under IDs to connect.

- Manual Connection. Set the COM port, the baud (data transfer) rate, and the address, and Click Connect.

If you are using a USB connection, check the Windows Device Manager to see which COM port is mapped to the Servo Drive USB device.

The port address can be any value, from 0 to 99. The value you enter must match the drive address defined by the rotary switches (set during installation). Refer to the section Set the Drive Address.

5.5 Drive Information

The Drive Information screen displays basic information about the MSHD, such as current rating, hardware version and firmware version. It is important to provide this information to Technical Support when asking for assistance.

This screen also provides access to the Firmware Download utility. Refer to the chapter Firmware Upgrade.

Figure 5-6. ServoStudio – Drive Information Screen

Drive Name	Allows you to assign a name to the drive. The name may contain up to 15 alphanumeric characters. Other valid characters are ( ) / - . : This field is optional, but is useful when an application has more than one drive. It is recommended that you provide a name for the drive that reflects the function it performs, such as Axis-1. Refer to VarCom DRIVENAME.
Drive Details	Hard-coded in the drive. Shows the drive model and serial number, and version numbers of firmware, control board, power board and FPGA. Refer to VarCom INFO.
Drive Settings	Hard-coded in the drive. Drive Peak Current – Refer to VarCom DIPEAK. Drive Continuous Current – Refer to VarCom DICONT. Feedback Type – Refer to VarCom FEEDBACKTYPE. If modified, CONFIG is required.
Download Firmware	Activates an external application for installing new versions of firmware in the drive. Refer to the chapter Firmware Upgrade.

5.6 Power Rating

The Power Rating screen displays the drive's continuous and peak current ratings, and allows you to set the bus voltage parameters.

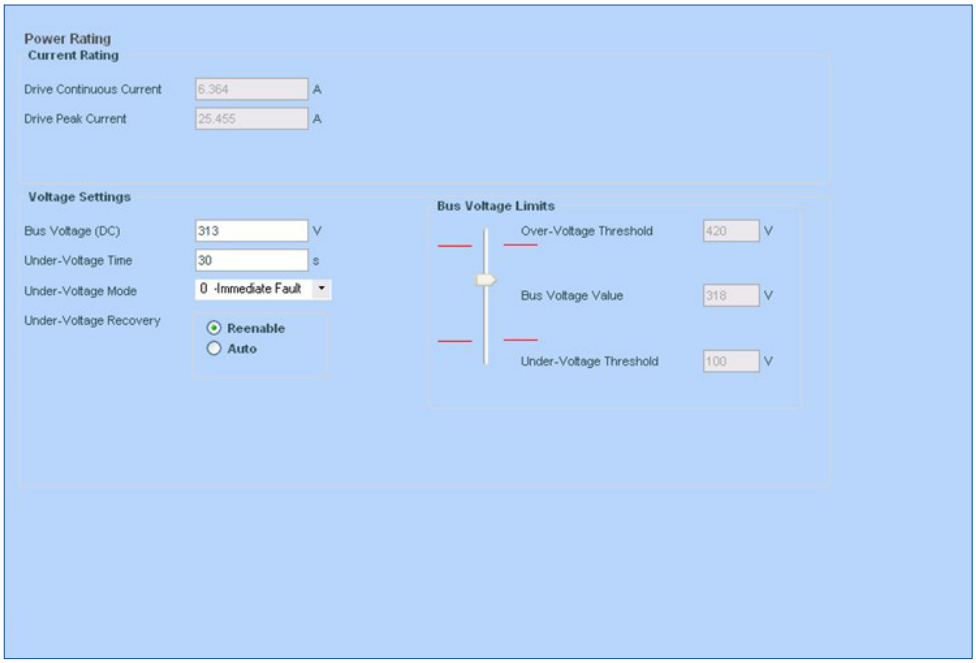


Figure 5-7. ServoStudio - Power Rating Screen

Current Rating	Hard-coded in the drive. Drive Continuous Current – Refer to VarCom DICONT. Drive Peak Current – Refer to VarCom DIPEAK.
Voltage Settings	Bus Voltage (DC) – This setting is required for basic current loop tuning. Although the drive monitors the bus voltage, you must enter the nominal bus voltage here.Enter 320 for a drive powered by 220 VAC per phase. Enter 160 for a drive powered by 110 VAC per phase.Refer to VarCom VBUS. If modified, CONFIG is required. Under-Voltage Time – Specifies the amount of time an under-voltage condition will exist before latching a fault,when working in Delayed Fault Under-Voltage mode. Refer to VarCom UVTIME.. Under-Voltage Mode – Defines how the drive will respond to an under-voltage fault. Refer to VarCom UVMODE. Under-Voltage Recovery – Defines how the drive will recover from an under-voltage fault: by toggling the drive from disable to enable, or by automatically recovering, after the under-voltage condition clears. Refer to VarCom UVRECOVER
Bus Voltage Limits	Read only. Shows the actual bus voltage of the drive. Refer to VarCom VBUSREADOUT.

5.7 Motor

The Motor screen allows you to select a motor from the ServoStudio database. You can simply select the motor family and motor part number, and ServoStudio will prepare the appropriate motor and feedback parameters.

Select Write to Drive to send the parameters to the drive.

The screen also allows you to read parameters from the drive, and save parameters.

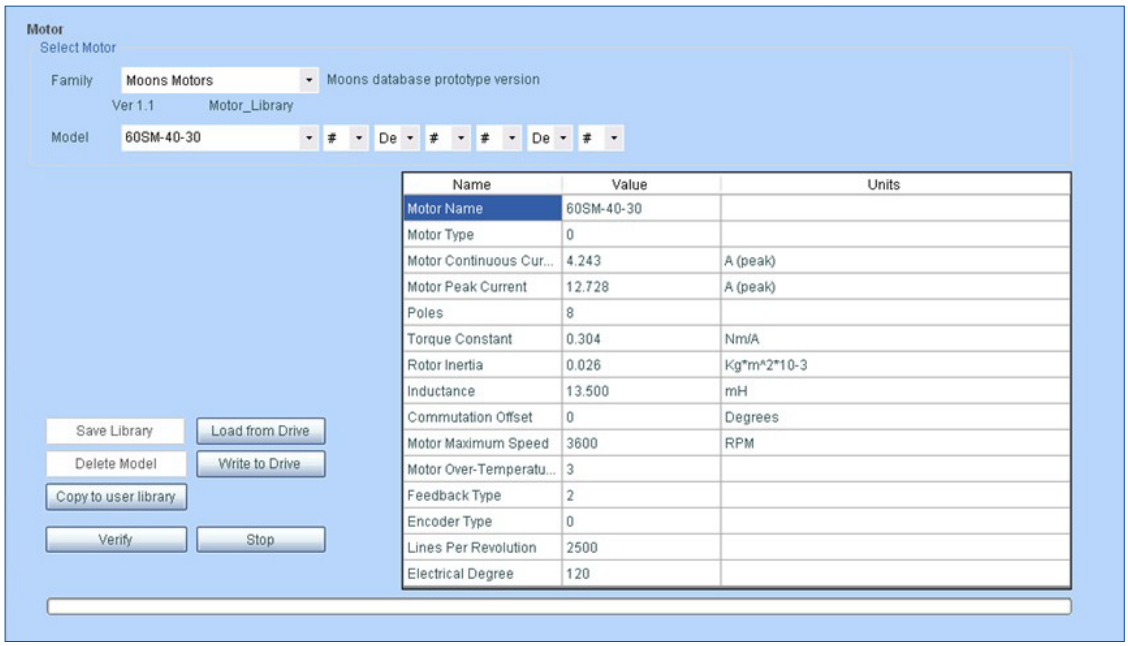


Figure 5-8. ServoStudio – Motor Screen

5.7.1 Motor Selection

Motor Family	ServoStudio has a database containing predefined sets of parameters for motors. User Motors contains a list of motors whose parameter sets have been created by the user, either by modifying a predefined set, or by defining an entirely new set of parameters for a motor. To add a motor to this list, select Motor Family>User Motors, and then Motor Type>New. The Parameters Table then displays a list of motor properties that need to be defined.
Motor Model	A list of all models in the selected Motor Family that have a predefined set of parameters in ServoStudio. For most motors, the motor catalog number is followed by a series of fields, each of which represents a segment in the motor's complete ID number, as shown on the motor's label. In each field select the option that matches the information on the motor label. If a field contains a # sign, you do not need to select an option, as the field is not relevant to motion. Different fields represent certain functions or capabilities of the motor, which can be seen in the tooltip for each field. Depending on your selections, you may be prompted to define the output that releases the motor brake. After selecting the motor click Write To Drive to write these parameter to the drive.

5.7.2 Motor Parameters

Save Library	Saves the entire contents of the User Motors library to a file.
Delete Model	Deletes the currently displayed motor from the User Motors library.
Load from Drive	Displays the values of the drive's motor parameters.
Write to Drive	Writes all displayed parameters to the drive. You can also modify a parameter value and press Enter to send the new value to the drive.
Copy to User Library	Copies the parameter values currently displayed to the User Motors library, to enable modification.
Verify	Activates an automatic procedure for setting commutation related variables. The procedure involves finding the electrical phase and detecting the direction of motor movement, Hall switches and index crossing. The drive's 7-segment display flashes the character A during this procedure. When the procedure finishes successfully, the display returns to its normal state. If the procedure fails, the display shows -5. Refer to the section Motor Phasing and to VarCom MOTORSETUP.
Stop	Aborts the Verify process.
Progress bar	Shows the progress of the Verify process (which takes about 30 seconds).
Click for Details	Shows more information about the Verify process.

The **Parameter Table** displays the parameters of the selected motor as currently defined in the database, or as read from the drive. As soon as you change any Motor Model field, the values in the Parameter Table change accordingly.

The Parameter Table presents the following information:

Name	Name of the variable.
Value	Value of the variable. You can modify a parameter value and press Enter to send the new value to the drive. Alternately, use Write to Drive to send all displayed parameters to the drive.
Unit	Unit of the variable.

5.8 Motor Feedback

THE MSHD supports various motor feedback technologies and devices, including:

- Incremental A-quad-B encoder, with or without Hall sensors (or commutation tracks)
- Resolver(Please contact us for more information.)
- Sine encoder(Please contact us for more information.)
- Communication encoder (such as SSI encoders)(Please contact us for more information.)
- Sanyo Denki PA Absolute Encoder(Please contact us for more information.)

For technical details, refer to the section

Feature	Specification	
First Analog Input	Voltage Range	Analog ±10 VDC differential
	Input Resolution	16 bit (14-bit on version with two analog inputs)
	Input Impedance	8 kΩ (when using two analog inputs 20k Ω.)
Second Analog Input (optional)	Voltage Range	Analog ±10 VDC differential 14 bit
	Input Resolution	14 bit
	Input Impedance	20 kΩ
Equivalent Encoder Output	Signal	A-quad-B and marker differential, RS 422 line transmitter
8x Digital Inputs	Signal	Configurable opto-isolated (compatible with sinking output)
	Voltage	24 V
	Max. Input Current	10 mA
	Propagation Delay Time	1 ms
3x Fast Digital Inputs	Signal	Configurable opto-isolated (compatible with sinking output)
	Voltage	24 V
	Max Input Current	10 mA
	Propagation Delay Time	1 µs
4x Digital Output *	Signal	Configurable open collector, opto-isolated sinking output
	Voltage	24 V
	Max. Current	40 mA
	Propagation Delay Time	1 ms
2x Fast Digital Output	Signal	Configurable open collector, opto-isolated sinking output
	Voltage	24 V
	Max current	10 mA
	Propagation Delay Time	1 µs
Analog Output	Signal	Configurable analog output
	Voltage Range	0-10 V
	Resolution	8 bit
	Max. Load	1 kΩ

Secondary Feedback	Signal	A-quad-B and marker differential, RS 422 line receiver
	Max. Input frequency	3 MHz (before A-quad-B)
	Functions	Dual loop, Master/Slave or Handwheel
Fault Output Relay	Signal	Configurable dry contacts
	Voltage	24V
	Max. Current	1 A

Motor Feedback Specifications.

The variable FEEDBACK is used to define the type of motor feedback used in the drive application.

The **Feedback** screen enables you to configure the properties of the motor's feedback device, and to view the motor position. To configure feedback, select the feedback device from the Feedback options. The screen will change accordingly, enabling you to set the relevant feedback properties.

The Feedback screen also allows you to activate the encoder simulation output and set its resolution.

Note: Many motors have a predefined feedback device. Once you select a motor in the Motor screen, some of the fields in the Feedback screen will have values entered automatically.

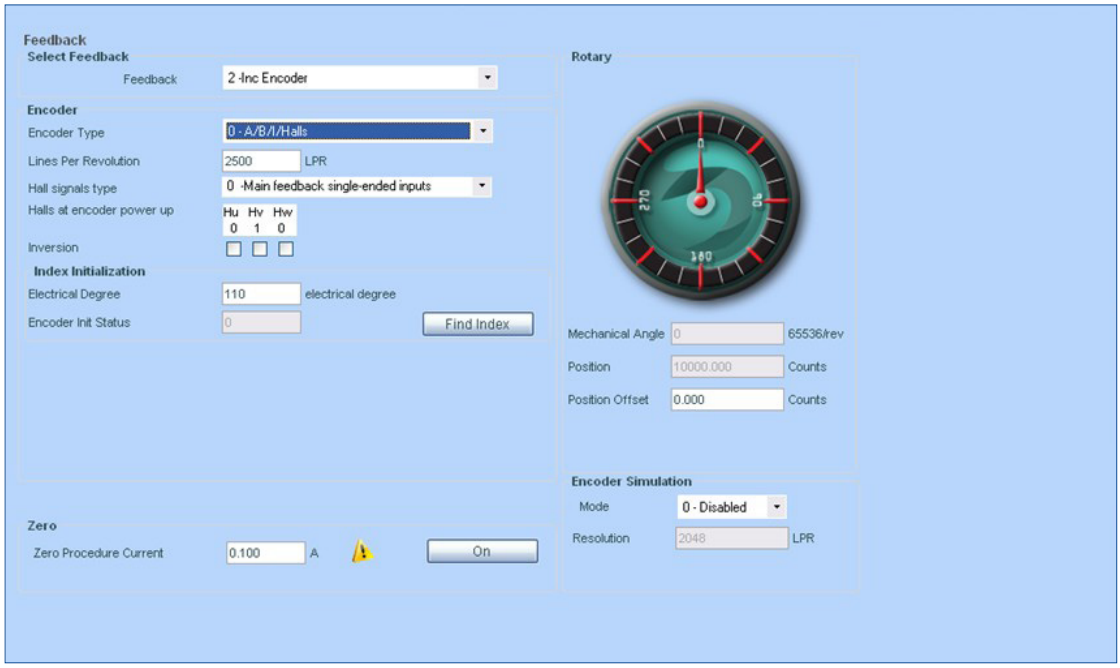


Figure 5-9. ServoStudio – Feedback Screen

More information about the feedback devices and parameters defined in this screen appears later in this section.

Feedback	Select the type of feedback being used in the application: 1 – Resolver (Please contact us for more information.) 2 – Incremental Encoder 3 – Sine Encoder (Please contact us for more information.) 4 – Sanyo Denki PA Absolute Encoder (Please contact us for more information.) Refer to VarCom FEEDBACKTYPE.
Zero	Zero Procedure Current – The current used for the Zero procedure. Refer to VarCom IZERO. On – Activates the Zero procedure, which locks the rotor in place by passing current through two phases. This is useful for determining the commutation offset (MPHASE) on motors that have a resolver or absolute encoder. Refer to VarCom ZERO.
Rotary	The graphic shows motor position within one revolution. After setting the feedback resolution, you can turn the motor by hand one revolution and use this graphic to verify that one revolution of position counts has indeed occurred. The graphic also shows motor direction and helps you verify that motion direction is as expected. Mechanical Angle – Read only. The motor mechanical angle position. Refer to VarCom MECHANGLE. Position – The value of the position feedback. Read only. Refer to VarCom PFB. Position Offset – A feedback offset that is added to the internal cumulative position counter, to give the position feedback value. Refer to VarCom PFBOFFSET.
Encoder Simulation	Enables the equivalent encoder output, and sets the resolution. Refer to the section Encoder Simulation Output. Mode – The state of the encoder simulation, either Disabled or Active. Refer to VarCom ENCOUTMODE. Resolution – The resolution, in number of lines, of the encoder equivalent output. Refer to VarCom ENCOUTRES.

The other options in this screen will change according to the selected Feedback type:

Encoder	If the selected feedback type is 2-Incremental Encoder, the encoder type and resolution must be defined: **Encoder Type** – Select one of the following options: 0 - A, B and index channels, and Halls. *1 - A, B and index channels, commutation initialization upon command. *2 - A, B and index channels, commutation initialization upon command or upon first enable. *3 - A and B channels, commutation initialization upon command. *4 - A and B channels, commutation initialization upon command or upon first enable. *6 - A and B channels, and Halls. *11 - A, B and index channels, and Halls, and Tamagawa. Refer to VarCom MENCTYPE. If modified, CONFIG is required. **Lines Per Revolution** – The resolution of the motor encoder. Refer to VarCom MENCRES. If modified, CONFIG is required. **Halls** – The current state of the Hall commutation sensors. Read only. Refer to VarCom HALLS.
Phase Find Process	Find Phase – Activates the automatic motor phasing routine. Refer to VarCom PHASEFIND.
Index Initialization	**Find Index –** Activates the automatic index location routine. Refer to VarCom INDEXFIND. For more information, refer to the section Encoder Index. **Electrical Degree** – The encoder index position. Refer to VarCom MENCZPOS. **Encoder Init Status** – The state of the index search and initialization procedure. Read Only Refer to VarCom INDEXFINDST. **Note:** If the motor has an index but the index is not being used for commutation (for example, if the encoder type is 6 – A/B/Halls), then you do not need to specify or find the index position.
Resolver	Displayed if selected feedback type is 1-Resolver. (Please contact us for more information)
Calibration	Displayed if selected feedback type is 1-Resolver or 3-Sine Encoder. (Please contact us for more information)
Sine Encoder	Displayed if selected feedback type is 3-Sine Encoder. (Please contact us for more information)
Communication Feedback	Displayed if selected feedback type is 4- Sanyo Denki PA Absolute Encoder. (Please contact us for more information)

*Please contact us for more information.

5.8.1 Incremental Encoder

Types and Resolution

The MSHD supports various types of incremental encoders.

The variable MENCTYPE defines the type of encoder being used on the motor. If this variable is modified, CONFIG is required.

The variable MENCRES defines the resolution of the encoder, in number of lines per revolution of the motor. If this variable is modified, CONFIG is required.

For an incremental encoder, the number of encoder counts per revolution is obtained by multiplying MENCRES by 4.

The MSHD monitors all encoder signal wires, and generates an A/B Line Break fault (lights r4 on the 7-segment display) if any wire is broken.

Hall Signals

The MSHD supports single-ended (or open-collector) Hall signals only. Differential Hall signals are not supported.

The variable HALLS is used to read the state of the Hall signals.

The MSHD monitors the state of the Hall signals, and generates an Illegal Halls fault (lights r6 on the 7-segment display) if either the 000 or the 111 state is detected.

Encoder Index

Encoders often have an additional channel, referred to as a marker channel, zero pulse, or index channel; these are different names for the same function. This channel outputs one pulse per revolution, and is typically an extremely narrow pulse equal to about one-quarter of the width of an A or B channel pulse, but it can be wider. The encoder index can be used for homing (absolute position reference) and for commutation alignment.

Caution: When using Encoder Type (MENCTYPE) 0, 1 or 2, the index pulse is used by the drive for additional commutation correction. In these instances, the index position must be located and defined using the Index Initialization procedure (INDEXFIND). If the index value is not set correctly, the motor might run out of control.

To determine the position of the index signal, use the Find Index command in the ServoStudio Motor Feedback screen, or use the VarCom INDEXFIND command.

The MSHD monitors the index signal wires, and will generate an Index Line Break fault (lights r5 on the LED) if any wire is broken

5.8.2 Sine Encoder

Sine encoders are very similar to incremental encoders. The difference is that sine encoders send the A and B channels to the drive as 1V peak-to-peak sinewaves while incremental encoders generate digital pulses.

(Please contact us for more information)

5.8.3 Resolver

A resolver is a rotary transformer that is used to measure the motor shaft position. The resolver has a primary winding, and two secondaries – a sine and cosine in sync with the motor rotation. The level of voltage on the sine and cosine waves correlates to the position of the shaft within one revolution.
(Please contact us for more information)

5.8.4 Encoder Simulation Output

An encoder simulation output, also referred to as an equivalent encoder output (EOO) or a buffered encoder output, is available on the Controller I/O connector.

- The variable ENCOUTMODE is used to turn the encoder simulation on or off, and to set the functionality.
- The variable ENCOUTRES is used to set the resolution, in equivalent linesper- revolution, of the encoder simulation.

5.9 Motion Units

The Motion Units screen lets you select the units used for defining position and velocity. The selected unit can be a user preference or a property of the type of motor being used.

For details, refer to the section Control Specifications.

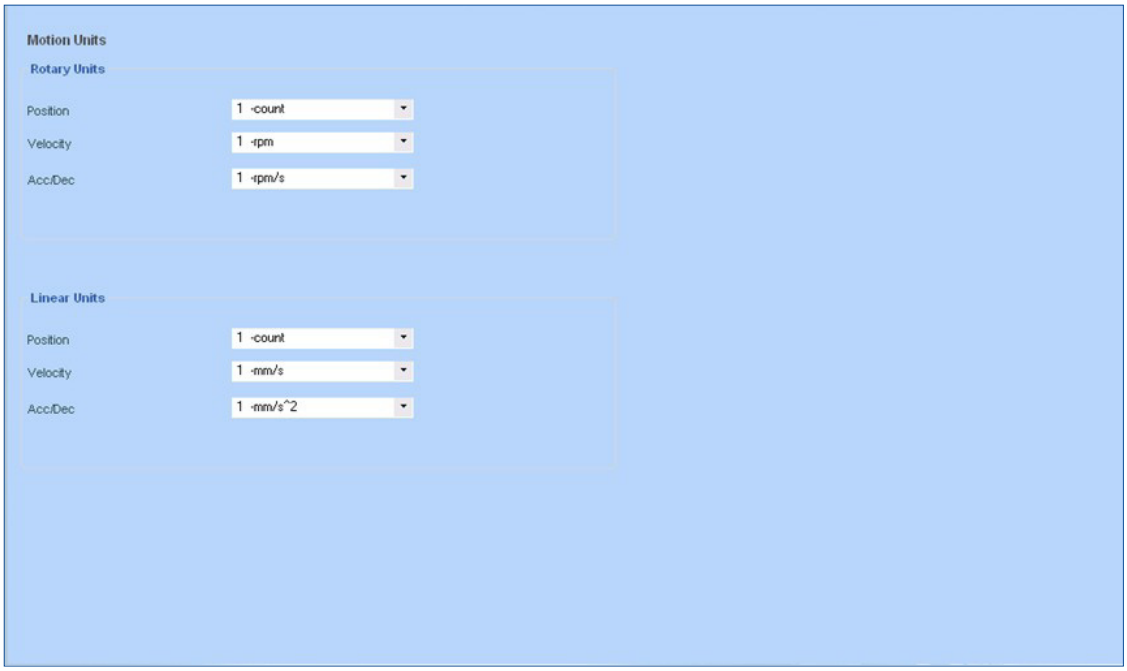


Figure 5-10. ServoStudio – Motor Units Screen

For the options for Rotary Units, refer to VarCom UNITSROTPOS, UNITSROTVEL and UNITSROTACC.

For the options for Linear units, refer to VarCom UNITSLINPOS, UNITSLINVEL and UNITSLINACC.

5.10 Current Limits

5.10.1 Basic Current Limit

The **Current Limits** screen contains a diagram that shows how the maximum current for the system is determined, and enables you to set the current limit for your application.

For instructions on using the schematic interface, refer to the section Schematic Diagrams.

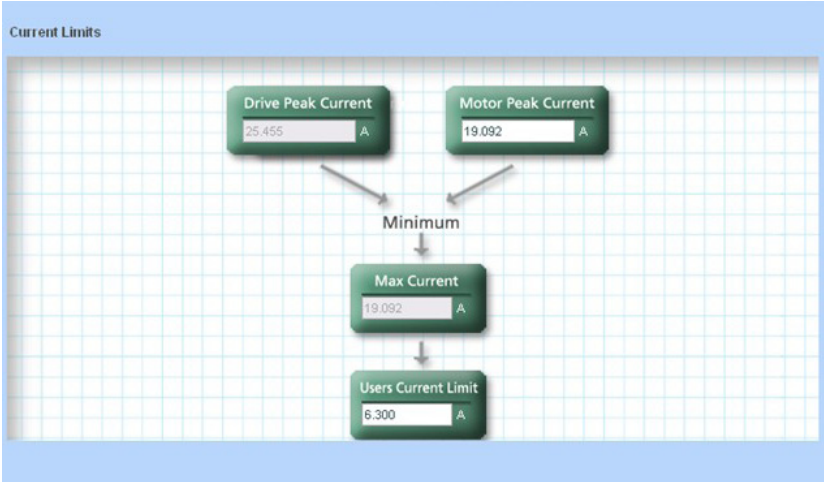


Figure 5-11. ServoStudio – Current Limits Screen

Drive Peak Current	Hard-coded in the drive. Read only. Refer to VarCom DIPEAK.
Motor Peak Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MIPEAK. If modified, CONFIG is required.
Maximum Current	This value is the maximum current calculated by the software. Read only. Refer to VarCom IMAX.
User Current Limit	You can set a value lower than the Maximum Current as the application current limit. Refer to VarCom ILIM.

5.10.2 Optional Analog Current Limit

When a second analog input is available on a MSHD unit, this second analog input can be used as an analog current limit.

- The variable ANIN2MODE defines whether or not the drive is operating in analog current limit mode.
- The variable ANIN2ISCALE is used to scale the current limit. The valid input voltage range for this functionality is 0-10 V, since current and current limits in the drive are positive values only. A negative analog input will be interpreted as zero.
- Effective drive current is limited to the minimum of ILIM and the analog current limit
- The variable ILIMACT can be used to read the effective current limit (minimum of ILIM and the analog current limit)

Refer to the section Analog I/Os.

5.11 Velocity Limits

The **Velocity Limits** screen contains a diagram that shows how the maximum velocity for the system is determined, and enables you to set the velocity limit for your system accordingly.

For instructions on using the schematic interface, refer to the section Schematic Diagrams.

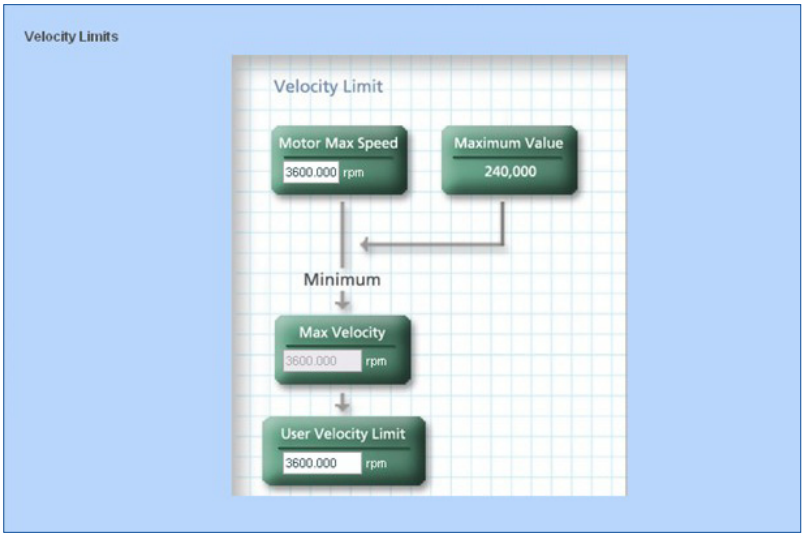


Figure 5-12. ServoStudio – Velocity Limits Screen

Motor Maximum Speed	The motor maximum speed is obtained from the motor datasheet. Refer to VarCom MSPEED. If modified, CONFIG is required.
Maximum Value	The maximum speed that the MSHD is able to compute. This value is hard-coded in the drive.
Maximum Velocity	The maximum allowed motor velocity is computed according to the values of the two preceding parameters. Read only. Refer to VarCom VMAX.
User Velocity Limit	The maximum application velocity can be set up to the value defined by VMAX. Refer to VarCom VLIM. If modified, CONFIG is required.

5.12 Foldback

Current foldback is a mechanism used by MSHD to limit the average current over time to the drive and/or the motor. Current foldback is set independently for the drive and for the motor. The current foldback mechanism protects the drive and/or motor from overheating due to excessive current.

The Foldback screen allows you to set the foldback properties of the drive and motor, and to activate the Motor Foldback function. Drive Foldback is always activated.

For instructions on using the schematic interface, refer to the section Schematic Diagrams.

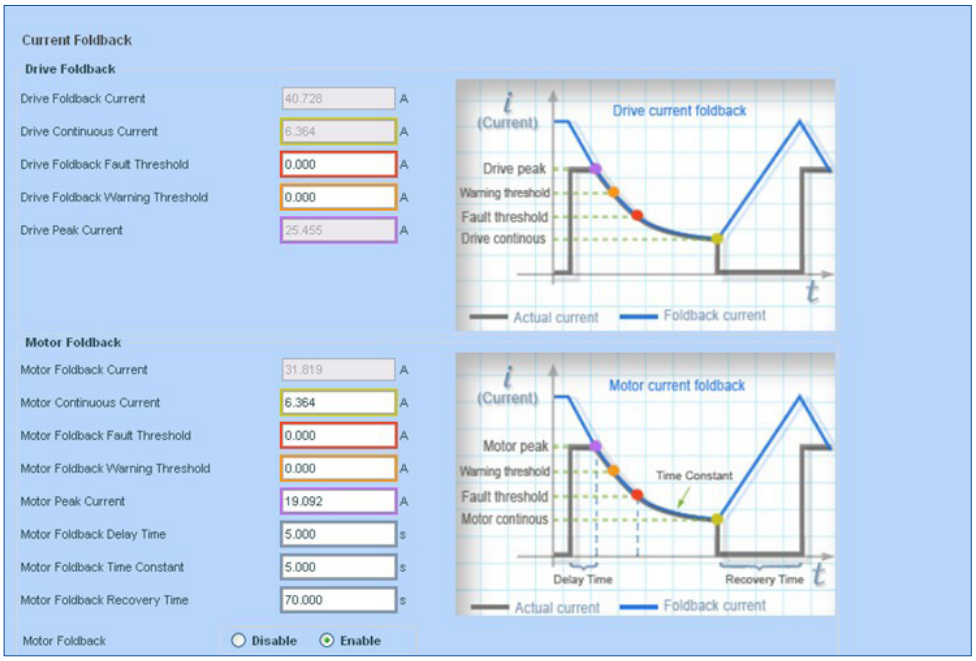


Figure 5-13. ServoStudio – Foldback Screen

5.12.1 Drive Foldback

Drive Foldback Current	Read only. Refer to VarCom IFOLD.
Drive Continuous Current	Hard-coded in drive. Read only. Refer to VarCom DICONT.
Drive Foldback Fault Threshold	Refer to VarCom IFOLDTHRESH.
Drive Foldback Warning Threshold	Refer to VarCom IFOLDWTHRESH.
Drive Peak Current	Hard-coded in drive. Read only. Refer to VarCom DIPEAK.

5.12.2 Motor Foldback

Motor Foldback Current	Refer to VarCom MIFOLD. Read only.
Motor Continuous Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MICONT. If modified, CONFIG is required.
Motor Foldback Fault Threshold	Refer to VarCom MIFOLDTHRESH.
Motor Foldback Warning Threshold	Refer to VarCom MIFOLDWTHRESH.
Motor Peak Current	This value is obtained from the motor datasheet. It can be manipulated. Refer to VarCom MIPEAK. If modified, CONFIG is required.
Motor Foldback Delay Time	Refer to VarCom MFOLDD.
Motor Foldback Time Constant	Refer to VarCom MFOLDT.
Motor Foldback Recovery Time	Refer to VarCom MFOLDR.
Motor Foldback	Options to enable and disable the Motor Foldback function. Refer to VarCom MFOLDDIS.

5.13 Inputs and Outputs

The MSHD supports programmable digital and analog inputs and outputs (I/Os).

The drive has both “regular” and “fast” I/Os, which are characterized as follows:

- Regular I/Os have a propagation delay in the range of several microseconds to several tens of microseconds.
- Fast I/Os have a sub-microsecond propagation delay.

The I/Os can be configured using the Digital I/Os and Analog I/Os screens in ServoStudio.

5.13.1 Digital I/Os

The **Digital I/Os** screen enables you to configure functionality and polarity of the digital I/Os, and to monitor the state of all digital I/Os.

Digital I/Os
Digital Inputs
State Name Mode Inversion Connector User Notes
Input 1 0 -Idle C_3 User Note 1
Input 2 0 -Idle C_20 User Note 2
Input 3 0 -Idle C_31 User Note 3
Input 4 0 -Idle C_14 User Note 4
Input 5 0 -Idle C_32_F User Note 5
Input 6 0 -Idle C_15_F User Note 6
Input 7 0 -Idle M_5 User Note 7
Input 8 0 -Idle M_15 User Note 8
Input 9 0 -Idle M_6 User Note 9
Input 10 0 -Idle M_16 User Note 10
Input 11 0 -Idle M_7_F User Note 11
Digital Outputs
State Name Mode Inversion Connector User Notes
Output 1 0 -Idle C_2 User Note 1
Output 2 0 -Idle C_33 User Note 2
Output 3 0 -Idle C_16_F User Note 3
Output 4 0 -Idle M_17 User Note 4
Output 5 0 -Idle M_8 User Note 5
Output 6 0 -Idle M_18_F User Note 6
Fault Relay Mode 0 -Close when no faults M_10_20 User Note 6

Figure 5-14. ServoStudio – Digital I/Os Screen

Digital Inputs

The MSHD has eight regular opto-isolated inputs and three fast opto-isolated inputs.

The functionality of each input can be set using the variable INMODE. This is necessary, for example, to make the drive recognize a Remote Enable signal.

The inputs can be read individually by the variable IN, or they can be read all together by the variable INPUTS.

The polarity of the inputs can be set using the variable ININV.

The following table shows the identification of the inputs, their type, and their location on the I/O connectors.

Input Number	Type	Location
IN 1	Regular	Controller I/O, pin 3
IN 2	Regular	Controller I/O, pin 20
IN 3	Regular	Controller I/O, pin 31
IN 4	Regular	Controller I/O, pin 14
IN 5	Fast	Controller I/O, pin 32
IN 6	Fast	Controller I/O, pin 15
IN 7	Regular	Machine I/O, pin 5
IN 8	Regular	Machine I/O, pin 15
IN 9	Regular	Machine I/O, pin 6
IN 10	Regular	Machine I/O, pin 16
IN 11	Fast	Machine I/O, pin 7

Digital Outputs

The MSHD has four regular opto-isolated outputs and two fast opto-isolated outputs. The functionality of each output can be set using the OUTMODE variable.

This would be necessary, for example, to make the drive switch on an output when there is a fault (alarm).

The outputs can be read individually using the OUT variable, or they can be read all together using the OUTPUTS variable.

The polarity of the outputs can be set using the OUTINV variable.

The following table shows the identification of the outputs, their type, and their location on the I/O connectors.

Input Number	Type	Location
OUT 1	Regular	Controller I/O, pin 2
OUT 2	Regular	Controller I/O, pin 33
OUT 3	Fast	Controller I/O, pin 16
OUT 4	Regular	Machine I/O, pin 17
OUT 5	Regular	Machine I/O, pin 8
OUT 6	Fast	Machine I/O, pin 18

5.13.2 Analog I/Os

The Analog I/Os screen lets you set various properties of the analog inputs, such as offset level, low pass filter, and deadband range. It also allows you to monitor the state of the analog inputs.

For instructions on using the schematic interface, refer to the section Schematic Diagrams.

Analog Input 1

The MSHD supports either one 16-bit analog input or two 14-bit analog inputs. One of the digits in the part number indicates whether the drive is assembled to support one or two analog inputs. Both analog inputs are differential.

The primary analog input, Analog Input 1, is connected at pins 8 and 26 of the Controller I/O connector. It serves as the analog command for the Analog Current and Analog Velocity operating modes. The functionality of this analog input cannot be changed.

Refer to the sections Analog Current Mode and Analog Velocity Mode.

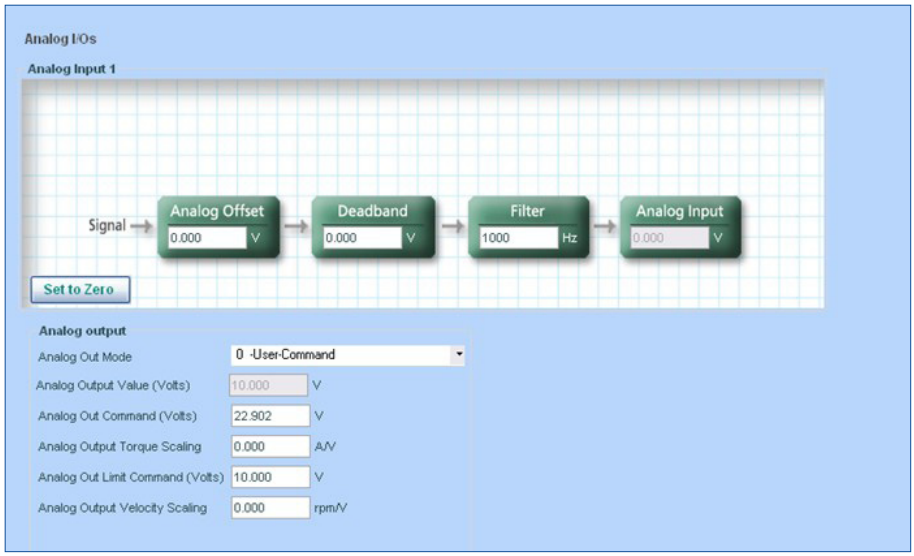


Figure 5-15. ServoStudio – Analog I/Os Screen – Analog Input 1

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET.
Deadband	The deadband range of analog input 1. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. Refer to VarCom ANIN1DB.
Filter	This value is a low-pass filter applied to the analog input. This is useful for filtering high frequency noise from the input, or for limiting the rate of change of that signal. Refer to VarCom ANIN1LPFHZ.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.
Set to Zero	Causes the value of the analog input 1 signal to become 0 by modifying the analog offset value. Refer to VarCom ANIN1ZERO.

Analog Input 2

Analog Input 2 appears in the Analog I/Os screen only when the connected drive has a second analog input.

The second analog input is connected at pins 18 and 35 of the Controller I/O connector.

When the second analog input is set up (using ANIN2MODE) to be an analog current limit, then ANIN2SCALE sets the scaling of the current limit in units of amperes per volt. Refer to the section Optional Analog Current Limit.

Figure 5-16. ServoStudio – Analog I/Os Screen – Analog Input 2

Function	Defines the functionality of the second input. Refer to VarCom ANIN-2MODE.
Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN2OFF-SET.
Deadband	The deadband range of analog input 2. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. Refer to VarCom ANIN2DB.
Filter	This value is a low-pass filter applied to the analog input. This is useful for filtering high frequency noise from the input, or for limiting the rate of change of that signal. Refer to VarCom ANIN2LPFHZ.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN2.
Set to Zero	Causes the value of the analog input 2 signal to become 0 by modifying the analog offset value. Refer to VarCom ANIN2ZERO.

5.14 Enable/Disable

5.14.1 Drive Enable

Caution: Enabling the drive might cause the motor to move.

The **Enable & Faults** screen graphically shows the conditions required for the drive to be enabled. It allows you to clear faults and turn on Software Enable.

As long as any light in the diagram is red, the drive remains disabled. When all lights are green, the drive is enabled.

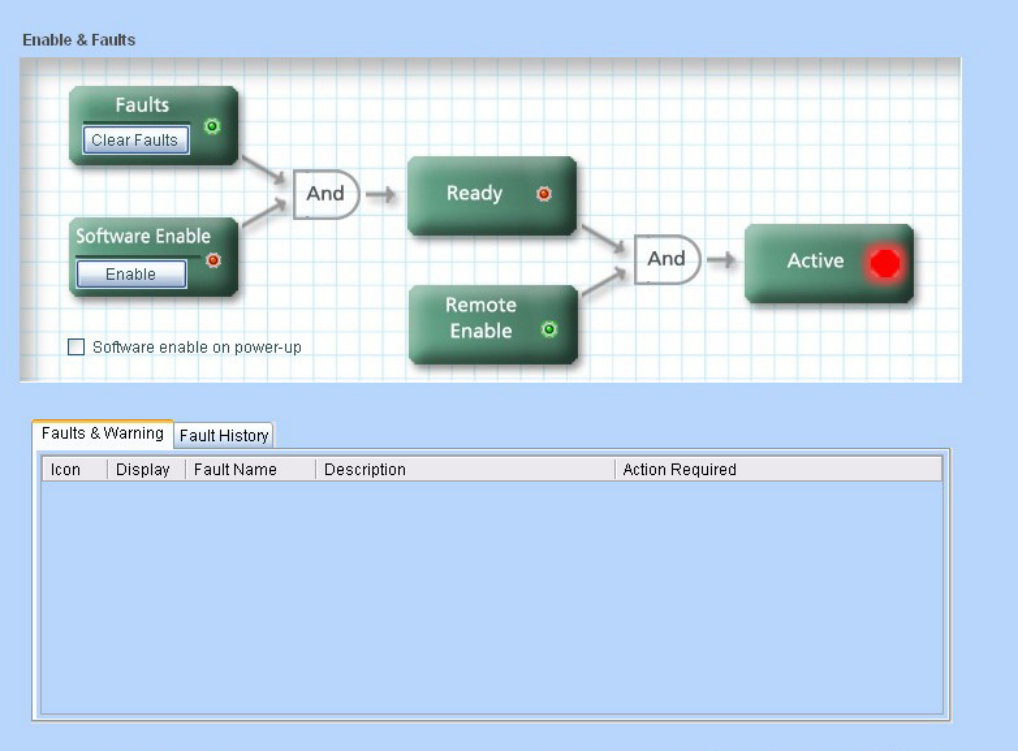


Figure 5-17. Enable & Faults Screen

The Enable & Faults screen includes the Faults panel which displays a list of all faults and warnings currently in effect, and a list of faults that have occurred in the present working session. For more information about warnings, faults and status messages, refer to the chapter Troubleshooting.

Three conditions are required for enabling the MSHD drive:

- No Faults. The drive can be enabled only when no faults exist. Once all faults are cleared, the drive is ready for activation (READY).
- The Software Enable switch must be on. This can be executed in one of the following ways:
- The commands EN (Enable) and K (Disable) toggle the state of Software Enable.
- The Enable|Disable button in ServoStudio toggles the Software Enable switch, provided that no faults exist.

  By default, the drive powers up in the Software Enable off state. It can be set to power up in the on state by the variable SWENMODE. The variable SWEN returns the state of Software Enable.

  Note: For SWENMODE to take effect, the variable COMMODE must be set to 0.

If Software Enable is on at power up, the drive can be enabled and disabled solely by means of the Remote Enable signal.

- The Remote Enable signal must be on. Remote Enable is a signal in the range of 5—24 VDC that is applied to one of the opto-isolated digital inputs in the Controller I/O connector.

  If no input is configured for this function, the Remote Enable signal remains on, and the drive can be enabled and disabled solely by the commands EN (Enable) and K (Disable).

  The variable INMODE is used to configure the input that provides the Remote Enable function. The variable REMOTE returns the state of the Remote Enable signal.

5.14.2 Clearing Faults

After a fault condition is removed, the fault remains latched until cleared by any of the following methods:

- A Clear Faults command:
  - The **Clear Faults** button in the ServoStudio Enable & Faults screen.
  - The command CLEARFAULTS.
- Toggling the Enable state of the drive:
  - Toggling the **Software Enable** button in the ServoStudio Enable & Faults screen.
  - Toggling the Remote Enable input.

Once all faults are cleared, the drive is ready for activation (READY).

5.14.3 Fault History

The drive stores a log of the ten most recent faults. Use the Fault History tab to view the fault log. Refer to VarCom FLTHIST.

The **Clear Faults History** button is displayed when the log contains fault. Refer to VarCom FLTHISTCLR.

5.15 Tuning Wizard

The Tuning Wizard executes an autotuning process for the Non-Linear Position Controller. The controller and the autotuning process are designed to minimize position error during motion and to minimize settling time at the end of motion. Refer to the section Non-Linear Position Control Loop.

The Tuning Wizard overrides the user's units settings and works in the following units:

- Position: counts
- Velocity: rpm/s for rotary motors, and mm/s for linear motors
- Acceleration/deceleration: rpm/s2 for rotary motors, mm/s2 for linear motors

Step 1: Load Estimation

1. For automatic load estimation, select **Move and estimate load inertia**. or

   If you know the inertia of the load connected to the motor, select Known Load Inertia, and enter the value.

2. Click Start.

Start enables the drive and moves the motor!

ServoStudio estimates the load currently on the motor, and displays the results.

3. Click OK to send the calculated parameters to the drive.

4. Click the Next arrow to continue.

Step 2: Gain Optimization

1. Use the Left and Right buttons to bring the load to a position at which the motor can safely make a full rotation in each direction.
2. If necessary, adjust the Speed setting.
3. Click Start.

Start enables the drive and moves the motor repeatedly!

The motor moves back and forth continuously, while ServoStudio tests values at intervals throughout the range for each of the control loop parameters. Once it achieves the best result, it displays the optimal value in the parameter table.

The top bar shows the progress of the parameter currently being tested.

The lower bar shows the progress of the entire process.

4. If necessary, adjust the Move Command settings, and click Start to repeat the test.

Step 3: Test Quality of Motion

1. Click Start Tuning Test to send a Current command to the drive and plot the step response.

Start Tuning Test enables the drive and moves the motor!

The graph shows the velocity command generated by the point-to-point position profiler (PTPVCMD) and the position error (PE).

The wizard also displays the settling time and the position error window calculated by the system.

Note: The velocity and the position error graphs are scaled so that both fit into the frame. The Y-axis is marked in units of position error (counts).

The screen includes three buttons that let you examine the graph more closely, and another button for exporting results to a spreadsheet. The functions are also provided in the ServoStudio Scope screen.

	Toggle Cursor to Zoom	Toggles Zoom In and Zoom Out view of graph. When Zoom In is selected, a minus sign appears on the button. Using the left mouse button, click-and-drag to select an area on the graph for magnification.
	Toggle Zoom to Cursor	Cancels the cursor zoom. Hides/displays cursor line/s. When cursor is displayed, use left mouse button to select and position the cursor on the graph. Variable values at the cursor point are displayed in a floating box.
	Select Cursor	Displays a second cursor line. Click on the graph to position the second cursor.
	View in Excel	Copies recorded data to a temporary CSV file and opens Microsoft Excel to display it

2. Optionally, modify the Motion settings and/or the Gain setting, and repeat the test under different conditions:

- Target Position
- Cruise Velocity
- Acceleration/Deceleration
- NL Adaptive Gain Scale Factor (KNLUSER); this is the global gain parameter for the Non-Linear Position loop. A higher gain value results in stiffer control, and a lower value results in softer control.

Step 4: Save

Do both of the following:

- 1. Click **Save to Drive** to save the parameters to the drive's non-volatile memory .
- 2. Click **Save to File** to save the parameters to a backup file on the computer.

6 Operation

6.1 Operation Modes

The MSHD can work in a number of operation modes. Each operation mode has a primary control loop (current, velocity or position) and a source of the command being recognized (analog or serial input). Analog Velocity mode, for example, indicates that the primary control loop is velocity and the drive will respond to a ±10 VDC analog command applied to the main analog input.

The operation mode is set using the variable OPMODE. The mode in effect is indicated on the 7-segment display by a steadily-lit single digit, as shown in the table below.

Table 6-1. Operation Modes

7-Segment Display	VarCom	Description
0	OPMODE 0	Serial velocity control
1	OPMODE 1	Analog velocity control
2	OPMODE 2	Serial current control
3	OPMODE 3	Analog current control
4	OPMODE 4	Gearing control
8	OPMODE 8	Profile Position control

Use the Motion screen to choose the operation mode and to set the relevant motion settings.

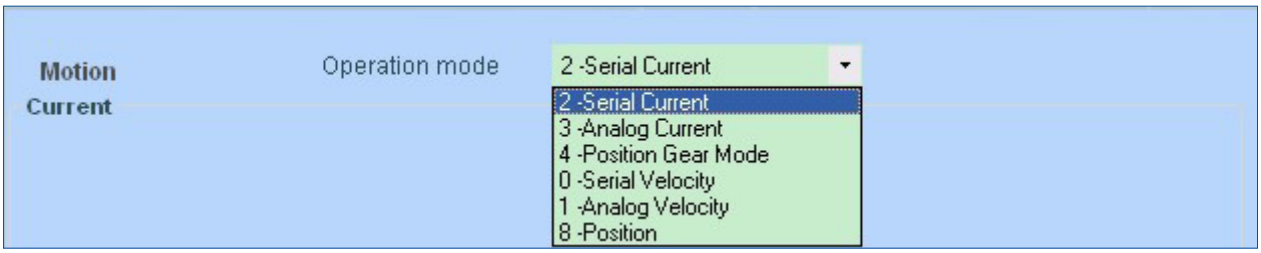


Figure 6-1. ServoStudio – Motion Screen

The Motion screen allows you to execute motion and to view the actual values of current, velocity and position. This is not real-time data, however, and the update rate depends on such factors as the host computer processing power and the drive mode of operation.

The schematic diagram and information displayed in the Motion screen varies according to the selected **Operation mode**.

6.2 Analog Current Mode

In the Motion screen select Operation Mode 3 - **Analog Current** to display the schematic and variables that affect the Analog Current command.

In Analog Current mode (OPMODE 3), only the MSHD's current loop is active, and the drive responds to a command from the primary analog input, connected at pins 8 and 26 of the Controller I/O connector.

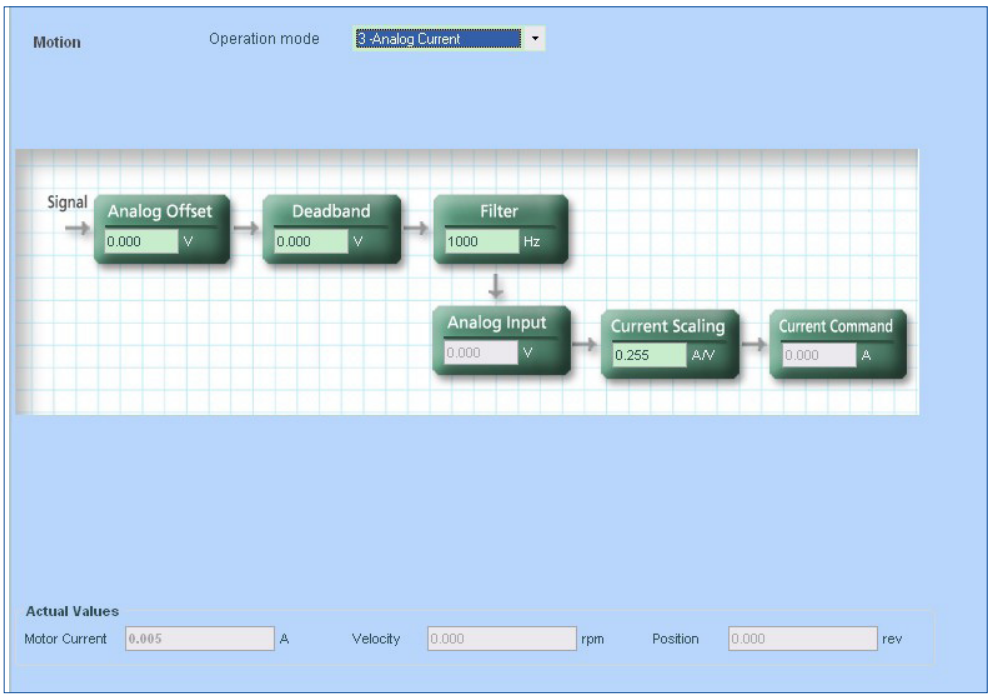


Figure 6-2. ServoStudio – Motion Screen – Analog Current Mode

In addition to tuning the current loop, certain drive variables need to be set.

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET.
Deadband	The deadband range of the analog input. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. Refer to VarCom ANIN1DB.
Filter	This value is a low-pass filter applied to the analog input. This is useful for filtering high frequency noise from the input, or for limiting the rate of change of that signal. Refer to VarCom ANIN1LPFHZ.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.
Current Scaling	When the first analog input is used as the command for the current loop, it is important to set the scaling, that is, the ratio of the analog input voltage to the command that the drive interprets. Refer to VarCom ANINISCALE.
Current Command	The resulting Current command. Refer to VarCom ICMD.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.3 Analog Velocity Mode

In the Motion screen select Operation Mode 1 - Analog Velocity to display the schematic and variables that affect the Analog Velocity command.

In Analog Velocity mode (OPMODE 1), the MSHD's current and velocity loops are active, and the drive responds to a command from the primary analog input, connected at pins 8 and 26 of the Controller I/O connector.

The commanded velocity is subject to a limit on the acceleration, defined by the variable ACC.

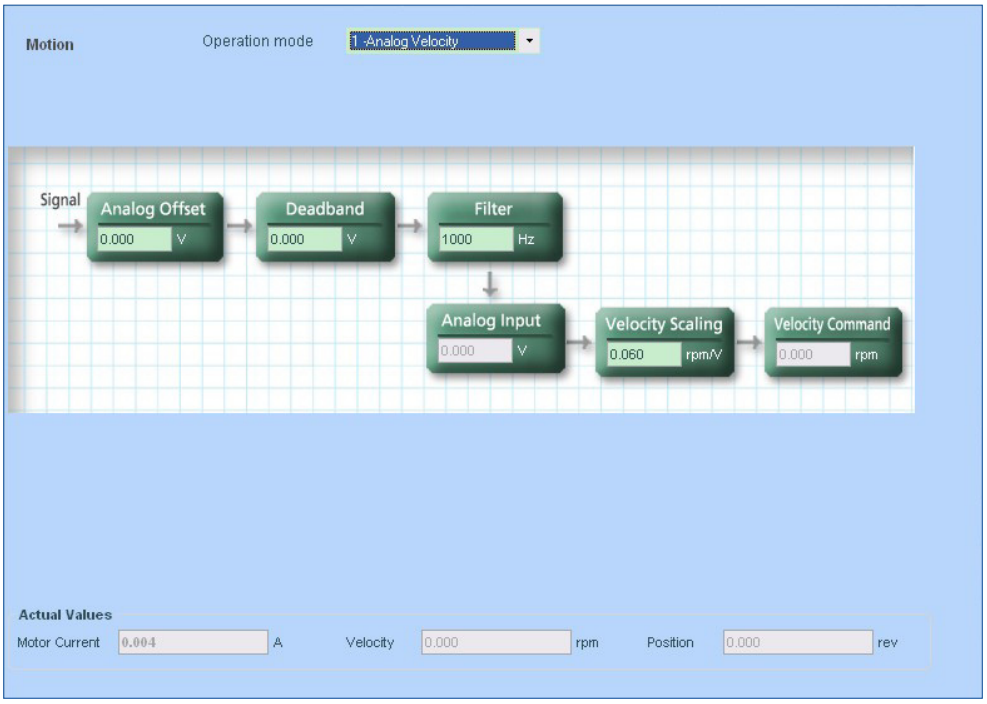


Figure 6-3. ServoStudio – Motion Screen – Analog Velocity Mode

In addition to tuning the current and velocity loops, certain drive variables need to be set.

Analog Offset	The DC voltage offset on the analog input. Refer to VarCom ANIN1OFFSET.
Deadband	The deadband range of the analog input. This is useful for preventing the drive from responding to voltage noise near the zero point of the analog input. Refer to VarCom ANIN1DB.
Filter	This value is a low-pass filter applied to the analog input. This is useful for filtering high frequency noise from the input, or for limiting the rate of change of that signal. Refer to VarCom ANIN1LPFHZ.
Analog Input	The voltage at the analog input. Read only. Refer to VarCom ANIN1.
Velocity Scaling	When the first analog input is used as the command for the velocity loop, it is important to set the scaling, that is, the ratio of the analog input voltage to the command that the drive interprets. Refer to VarCom ANINVSCALE.
Velocity Command	The resulting Velocity command. Refer to VarCom VCMD.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.4 Serial Current Mode

In the Motion screen select Operation Mode **2 - Serial Current** to display the schematic and variables that affect the Serial Current command.

In Serial Current mode (OPMODE 2), only the MSHD's current loop is active, and the drive responds to instructions received via the USB or RS232 ports.

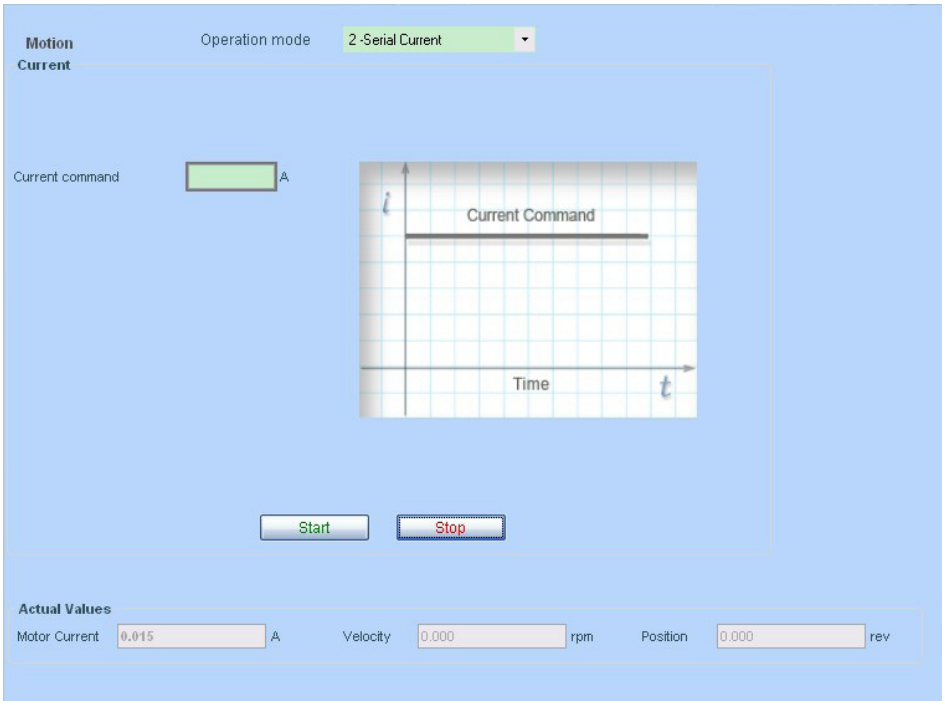


Figure 6-4. ServoStudio – Motion Screen – Serial Current Mode

Current Command	Sets the value of the current. Refer to VarCom T.
Start	Sends the Current command to the motor.
Stop	Stops the Current command.
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.5 Serial Velocity Mode

In the Motion screen, select Operation Mode **0 - Serial Velocity** to display the schematic and variables that affect the Serial Velocity command.

In serial velocity mode (OPMODE 0), the MSHD's current and velocity loops are active, and the drive responds to instructions received via the USB or RS232 ports. The commanded velocity is subject to programmable acceleration and deceleration limits.

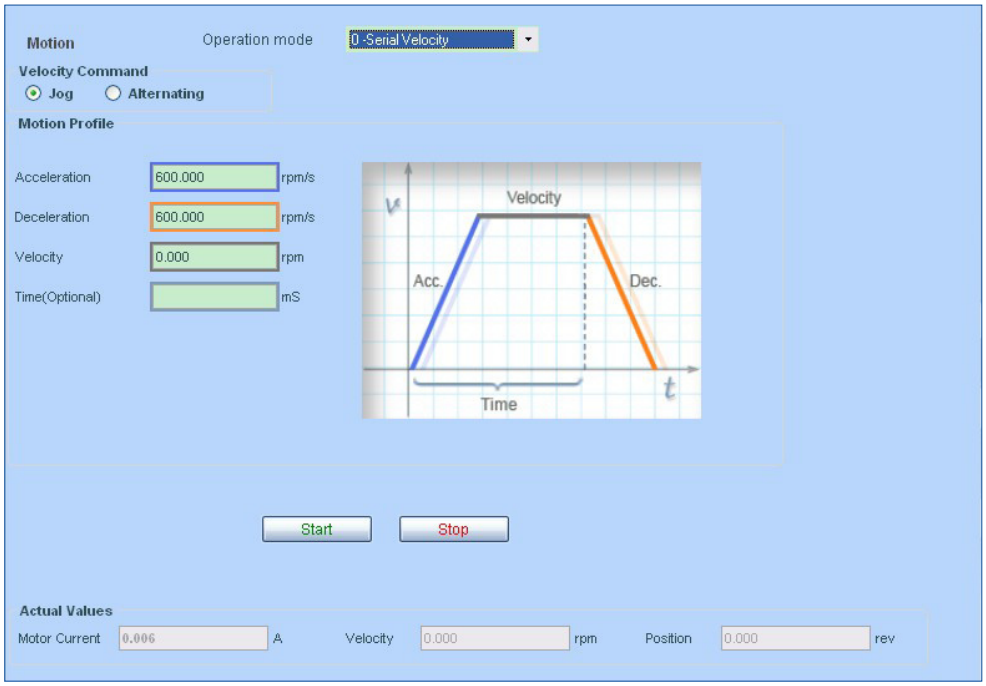


Figure 6-5. ServoStudio – Motion Screen – Serial Velocity Mode

Velocity Command	**Jog** – Moves the motor at a constant velocity. Refer to VarCom J. **Alternating** – Moves the motor at two alternating velocities by issuing two independent velocity command values, with each running for a specified time. Refer to VarCom STEP
Acceleration	Acceleration value. Refer to VarCom ACC.
Deceleration	Deceleration value. Refer to VarCom DEC.
Velocity/1/2	If **Jog** is selected, the velocity of the motion. If **Alternating** is selected, the command requires values for two velocity variables.
Time/1/2	If **Jog** is selected, the duration of the motion. If **Alternating** is selected, the command requires values for two time variables.
Start	Sends the Velocity command to the motor.
Stop	Stops the Velocity command
Actual Values	Shows the actual values of motor current, motor velocity and motor position.

6.6 Gear Mode

In the Motion screen, select Operation Mode 4 - Gear to display the schematic and variables that affect the Gear command.
In Gear mode, the MSHD's current, velocity and position loops are active, and the drive responds to incremental position pulses received from the controller or PLC.

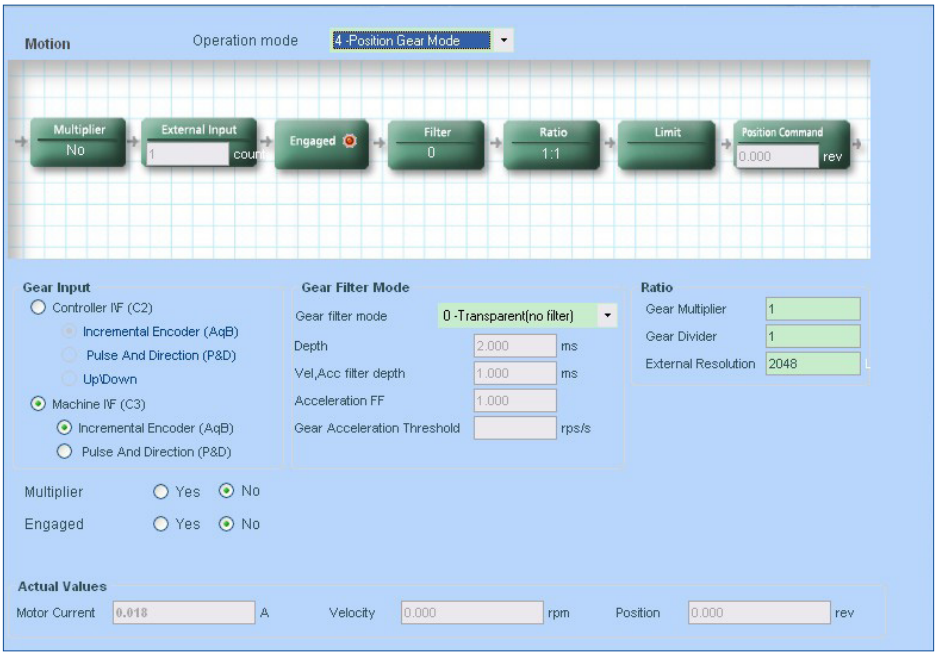


Figure 6-6. ServoStudio – Motion Screen – Gear Mode

The MSHD supports a several types of Gear modes. The variable GEARMODE instructs the MSHD which particular gear mode to activate.

6.6.1 Gearbox

Regardless of the GEARMODE used, the input signal is subject to gearing calculations that allow you to set the ratio of input pulses to encoder counts. Gearing sets up a relationship between the number of input pulses (HWPEXT counts) and the position increments of the motor shaft (or actual motor position, PFB). The rate at which position increments of the motor shaft (motor speed) occur is determined by the gearing relationship and the line frequency of the pulse train. The gearing relationship is as follows:

$$\frac{GEARIN}{GEAROUT} \times \frac{1}{XENCRES}$$

The direction of rotation is determined by the sign of the variable GEARIN.

The gearing function can be engaged or disengaged, using the variable GEAR.

In addition to tuning the current, velocity and position loops, the following drive variables must be set.

XENCRES	Resolution of the external pulse source. Refer to the sections below for more information.
Gear In	Numerator of the gearbox equation. Refer to VarCom GEARIN.
Gear Out	Denominator of the gearbox equation. Refer to VarCom GEAROUT.
Acceleration Limit	Refer to VarCom ACC.
Deceleration Limit	Refer to VarCom DEC.

6.6.2 Pulse and Direction Mode

In Pulse and Direction mode, if the absolute value of GEARIN is equal to GEAROUT, and if XENCRES is equal to 4×MENCRES (that is, the motor encoder resolution after quadrature), then one pulse on the input is equivalent to one count of the motor feedback.

As an example, assume that the motor encoder has a resolution of 2500 lines per revolution. Setting GEARIN=1, GEAROUT=1 and XENCRES=10000 will result in the motor making one revolution for every 10000 pulses (assuming the direction is fixed during this time).

The pulse and direction signals can be connected to either the Controller I/O connector or to the Machine I/O connector. The variable GEARMODE indicates to the drive where the signals are connected.

- Set GEARMODE to 1 to indicate to the drive that the signals are received from the controller or PLC on the Controller I/O connector (C2) at pins 28 and 11 (pulse), and 9 and 27 (direction).
- Set GEARMODE to 4 to indicate to the drive that the signals are received on the Machine I/O connector (C3) at pins 1 and 11 (pulse), and 2 and 12 (direction).

6.6.3 Master/Slave – Encoder Follower

In Master/Slave mode, the drive follows a quadrature encoder signal generated by a master device. The direction of motion is governed by the phase of the quadrature signals (A-lead-B or B-lead-A).

The master device can be, for example, a handwheel, a machine master encoder that is connected to the main camshaft, or the equivalent encoder output of another servo drive.

If the master device is a handwheel or a master encoder, then setting XENCRES equal to the resolution of the encoder (before quadrature) and setting the gear ratio to 1 will result in the motor making one revolution for each revolution on the input.

As an example, assume the handwheel resolution is 120 lines per revolution (that is, 480 counts after quadrature). Setting GEARIN=1, GEAROUT=1 and XENCRES=120 will result in one motor revolution for each turn of the handwheel.

The quadrature signals can be connected to either the Controller I/O connector or to the Machine I/O connector. The GEARMODE variable indicates to the drive where the signals are connected to.

Note: The Controller I/O connector cannot supply voltage to the handwheel or the machine master encoder. Only the Machine I/O connector can supply this voltage (pins 4 and 14 on connector C3).

- Set GEARMODE to 0 to indicate to the drive that the signals are received on the Pulse and Direction inputs on the Controller I/O connector (C2) at pins 28 and 11 (Quadrature A), and pins 9 and 27 (Quadrature B).
- Set GEARMODE to 3 to indicate to the drive that the signals are received on the Secondary Encoder inputs on the Machine I/O connector (C3) at pins 1 and 11 (Quadrature A) and pins 2 an 12 (Quadrature B).

6.6.4 Up/Down Counting

In an up/down counting system, pulses on one signal increment the motor position while pulses on the other signal decrement the motor position. The signals must be connected to the Controller I/O connector.

When the pulse signal is applied to the A channel, the external position counter (PEXT) increments and rotates the motor in a CW direction.

The pulse signal applied to the B channel decrements the external position counter (PEXT) and rotates the motor in a CCW direction.

The line frequency and the gearing relationship determine the speed and amount of the shaft movement.

- Set GEARMODE to 2 to indicate to the drive that the signals received on the Pulse and Direction inputs on the Controller I/O connector (C2) at pins 28 and 11 (Up) and pins 9 and 27 (Down).

6.7 Serial Position Mode

The MSHD has a dedicated mode of operation (OPMODE 8) for simple positioning applications over the serial port. Serial commands are transmitted from a host computer through the serial port. The command specifies the target position and the cruise velocity, while additional motion profile information (such as acceleration, deceleration and profile type) is set up using explicit variables.

In the Motion screen, select Operation Mode 8 - **Position** to display the schematic and variables that affect the Position mode motion setup.

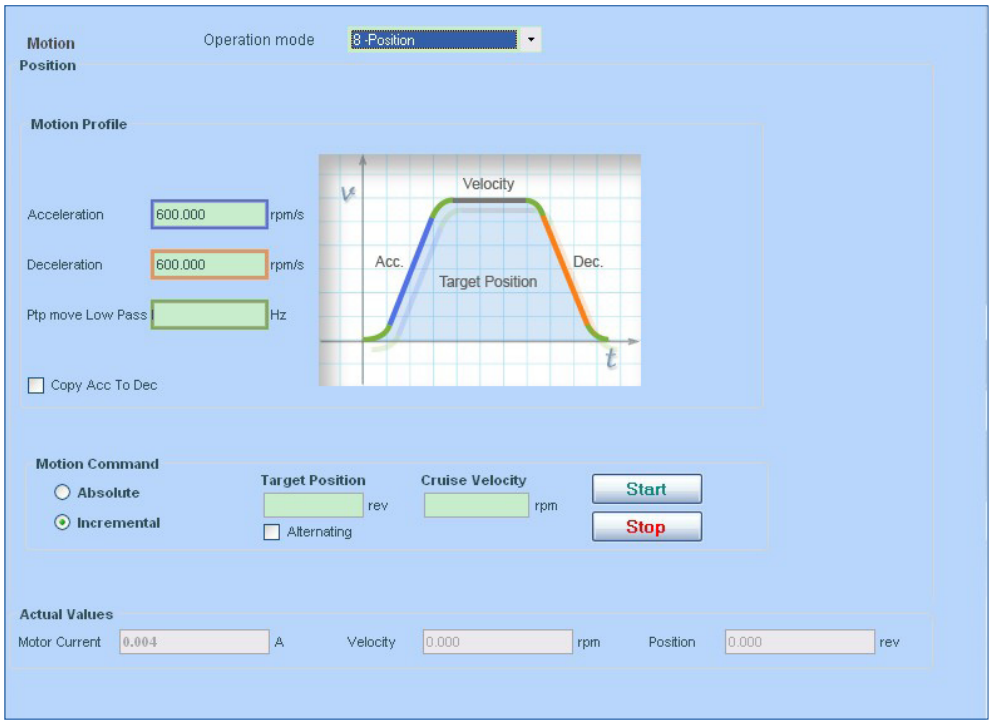


Figure 6-7. ServoStudio – Motion Screen – Serial Position Mode

6.7.1 Motion Profile Information

The motion profile is determined by the acceleration, deceleration and profile definitions.

Note: Only trapezoidal velocity profiles are supported in this product release.

To set the acceleration and deceleration, use the variables ACC and DEC, respectively.

The variable PCMD is used to read the position command.

The variable PFB is used to read the actual motor position.

Refer to VarCom ACC, DEC, PCMD, PFB.

6.7.2 Relative Motion

Relative, or incremental, motion moves the motor relative to the current position. Relative motion is always in reference to the current position of the load (and motor shaft), and is useful in indexing applications, such as cut-to-length feeders and rotary tables.

The reference point, defined internally to the drive, is the current value of variable PFB.

Movement can be in either direction, depending on the sign of the position value.

For example, if the target position is 1 revolution, the motor will turn one revolution from the starting point.

Refer to VarCom MOVEINC.

6.7.3 Absolute Motion

Absolute motion is always relative to an absolute reference point.
The reference point, defined internally to the drive, is the point at which the value of variable PFB is 0.
Refer to VarCom MOVEABS.

6.7.4 Position Error

The position error (also called following error) is the absolute value calculated as the difference between PCMD and PFB.
To read the position error, use the variable PE.
To set the maximum allowed position error, user the variable PEMAX. When the position error exceeds the PEMAX value, the drive will be disabled with fault j1.
Refer to VarCom PE and to the section j1.

6.7.5 In-Position Indication

The (read-only) variable INPOS is 1 when the motor is in position, and 0 when the motor is not in position.

The motor is in position when the value of PE is less than the value of the userdefined position error window, variable PEINPOS.

Whenever PE is less than PEINPOS, INPOS is set to 1, regardless of the state of the motion profile.

6.7.6 End of Motion

The motor is considered settled when the position error variable PE has remained below the position error threshold variable PEINPOS for a time defined by variable PEINPOSTIME.

The (read-only) variable STOPPED indicates the end of motion. While the position profile is being

executed STOPPED is set to 0. At the end of the profile, STOPPED is set to 1. When the motor has settled, STOPPED is set to 2.

6.7.7 Position Offset

The value of PFB can be modified, or offset, using the PFBOFFSET variable. This is useful for manual homing, or simply for testing incremental motion.

To set the current position to zero, do the following:

1. Disable the drive. (PFBOFFSET can be set only when the drive is disabled.)
2. Set PFBOFFSET to 0 (zero).
3. Read PFB
4. Set PFBOFFSET to the negative value of PFB

When using counts as the position units, PFBOFFSET can be set to a whole number (integer) only, even though the actual position, PFB, is displayed as a real number, with fractions of a count (which is a result of internal interpolation being executed on the encoder signal).

6.8 Motor Direction

When the motion command is positive, the direction of motion can be explicitly reversed. The positive direction for a rotary motor, for example, can be either clockwise or counterclockwise, depending on the application requirements.

One of the steps in the Setup Wizard allows you to test and reverse the direction of motion.

Alternately, use the VarCom variables DIR and MPHASE:

- Change the value of DIR to 1 if it is set to 0, or change it to 0 if it is set to 1.
- Change the value of MPHASE by 180.

Caution. Both values must be changed at the same time, before the drive is enabled, otherwise the motor might run away.

6.9 Disable Mode

The disabling of the drive may be due to an explicit command from the motion controller, or the drive's own response to a fault.

When the drive becomes disabled, the Disable mode function can be used in certain cases to bring the motor to a fast stop before power to the motor is shut off. This reduces the amount of motor coasting. The variable DISMODE defines if and how Disable mode is used to stop the motor.

The Disable mode function consists of two mechanisms:

- Active disable, by controlled deceleration and disable.
- Dynamic brake, by controlled motor short circuit.

6.9.1 Active Disable

Active Disable prevents motor coasting while the axis is disabled.
The Active Disable mechanism brings the motor to a stop by means of a controlled ramp down to zero velocity, and then disables the drive.
Note: Active Disable works only when the drive is in a velocity mode (OPMODE 0 or OPMODE 1).

Figure 6-8 shows how motor coasting occurs when Active Disable is not used. As soon as the drive is disabled, the velocity command is set to zero. The actual velocity then decreases as a function of the inertia and friction.

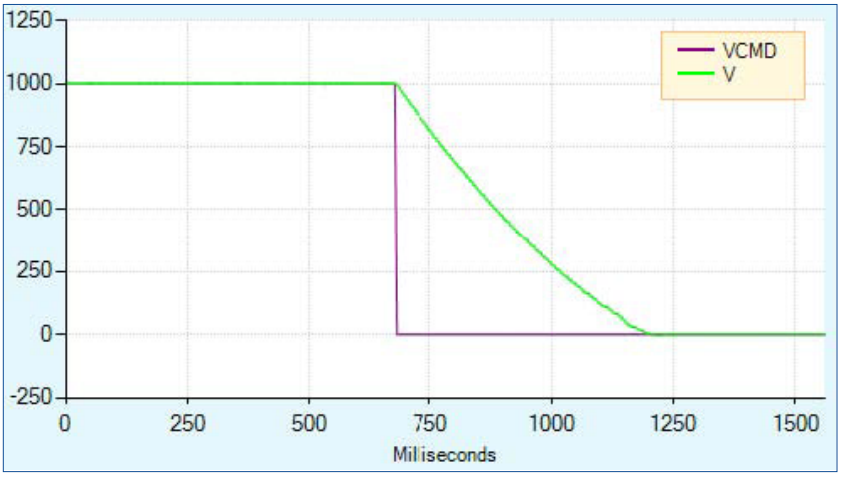


Figure 6-8. Disabling Without Active Disable

Figure 6-9 illustrates what happens when Active Disable is engaged. As soon as the drive receives the disable command, the velocity command is ramped down to zero, and only then is the drive disabled.

Three additional variables that influence the behavior of Active Disable.

- DISSPEED defines the velocity threshold below which the motor is considered stopped and the Active Disable timer starts the countdown to disable. The motor velocity must remain below this threshold for 100 consecutive drive background cycles. Each background cycle is approximately 1 ms.
- DISTIME defines the continuous time the motor must remain below DISSPEED before the drive is disabled. The DISTIME counter begins only after motor velocity has been below DIS-SPEED for 100 consecutive background cycles.
- DECSTOP defines the deceleration rate of the ramp down.

Figure 6-10 shows the effect of DISSPEED and DISTIME. In this example, DISSPEED is set to 1000, and DISTIME is set to 1 ms. After the motor speed remains below 1000 for 100 consecutive background cycle, and the time defined by DISTIME elapses, the drive is disabled and the motor coasts to a stop.

In this example, approximately 110 ms elapse from the time the motor velocity goes below 1000 and the time the drive is disabled.

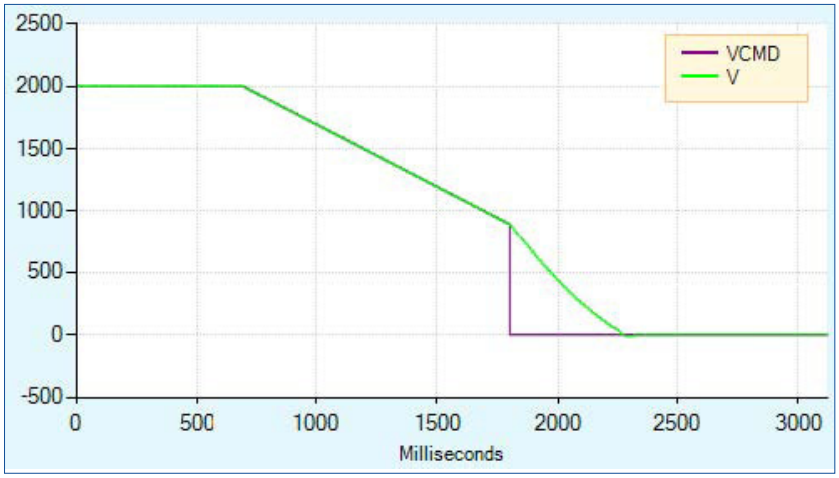


Figure 6-10. Effect of DISSPEED and DISTIME on Active Disable

During the Active Disable ramp down, the drive ignores any new motion commands.

If an additional disable command (VarCom K) is issued during the ramp down, the ramp down process is aborted and the drive is immediately disabled.

Figure 6-11 shows the effect of a second disable command. In this example, DISSPEED is set to 1000, and a second disable command is issued before the motor speed has ramped down to that level.

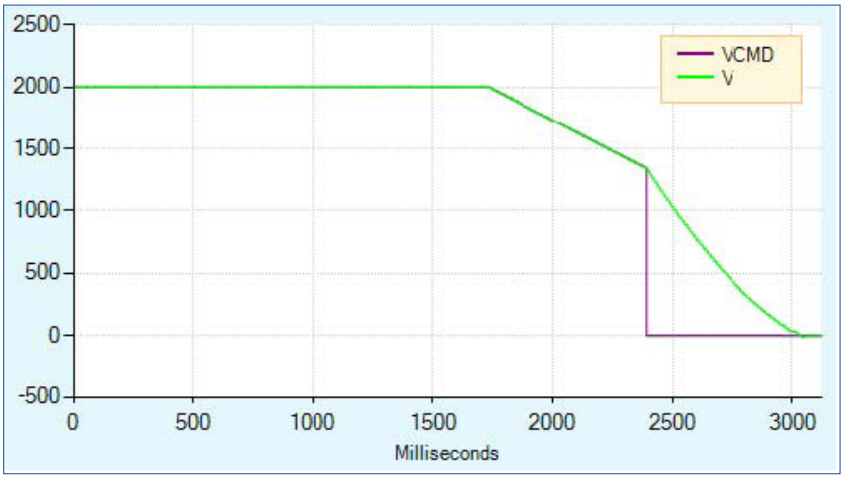


Figure 6-11. Effect of Second Disable Command on Active Disable

The diagram in the Servo Studio Disable Stop screen illustrates the behavior of Active Disable.

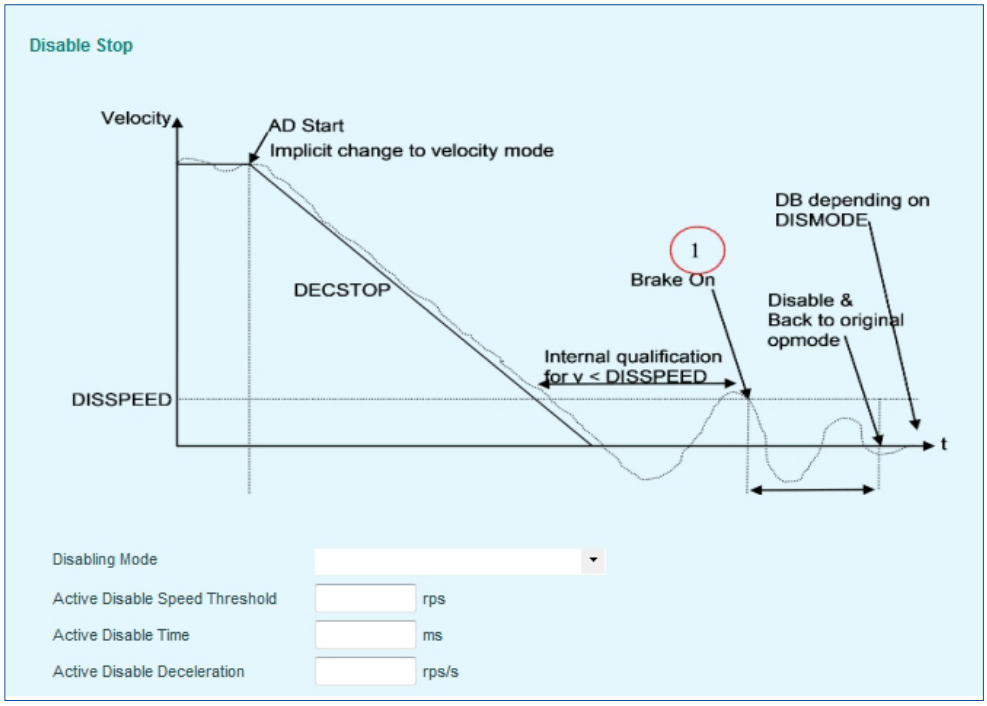


Figure 6-12. ServoStudio – Disable Stop

Notes:

- If one of the digital outputs is configured for brake control, then the brake will be engaged as soon as the DISTIME timer begins counting. Refer to the section Motor Brake Control.
- If the internal timeout (which is calculated according to the actual velocity and DECSTOP) expires, the ramp down mechanism will also abort, as indicated by 1 in the Disable Stop diagram.

6.9.2 Dynamic Brake

Dynamic braking is a mechanism by which the drive is holding the motor during Disable mode, where only the motor's back EMF is used to apply the stopping current. The variable ISTOP is used to set the maximum current allowed during the dynamic braking process.

Figure 6-13 illustrates motor coasting, that is, no Dynamic Braking (and no Active Disable). The velocity command is set to 0 as soon as the drive is disabled.
The actual velocity then decreases as a function of the system inertia and friction.

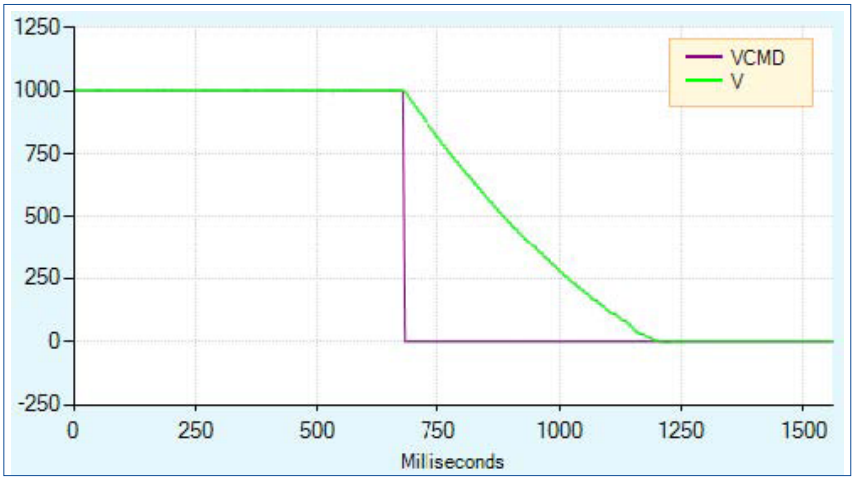


Figure 6-13. Motor Coasting, Without Dynamic Braking

Figure 6-14 shows what happens when Dynamic Braking is engaged. As in thefigure above, the velocity command is set to 0 as soon as the drive is disabled. However, the actual velocity ramps down as the braking is applied.

Unlike Active Disable, the velocity does not ramp down according to a motion profile. The ramp down rate is a function of the maximum current allowed (variable ISTOP) and the system inertia and friction.

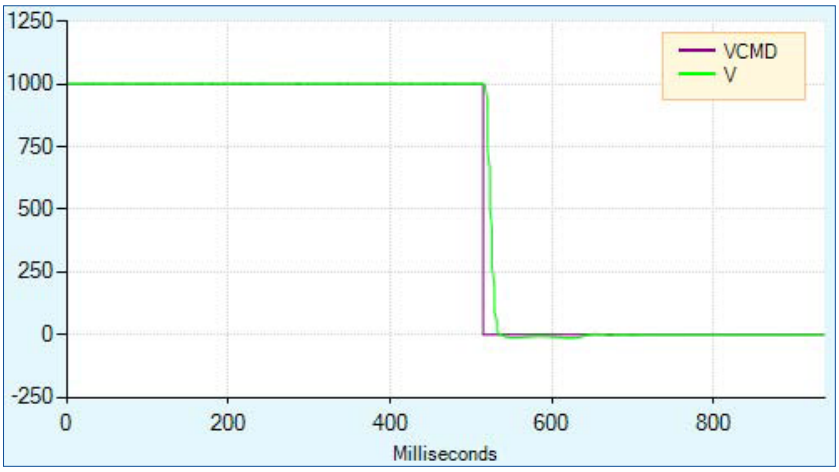


Figure 6-14. Dynamic Braking

Figure 6-15 shows Dynamic Braking with a very low value of ISTOP. In this instance, it takes longer to bring the motor to a stop.

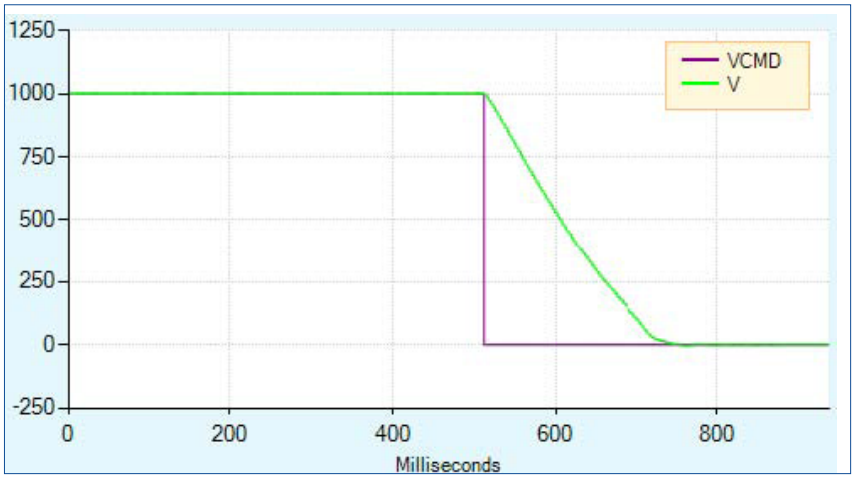


Figure 6-15. Dynamic Braking with Low ISTOP Value

In DISMODE 4 and DISMODE 5 both Active Disable and Dynamic Braking are supported. In these cases, Active Disable is used to bring the motor to a stop, and Dynamic Braking is activated after DISTIME.

6.10 Motor Brake Control

The MSHD can control a motor brake control circuit via a digital output. To do this, configure a digital output so that it is set to Brake mode. Refer to VarCom OUTMODE.

The brake engage time is programmable. When the drive receives a Disable command, it first switches off the brake output and then waits for the engage time before actually becoming Disabled.

The brake release time is not programmable. When the drive receives an Enable command, it simultaneously switches on the brake output and becomes enabled.

The drive needs a maximum of 1.5 milliseconds to become enabled, while a brake typically takes tens of milliseconds to disengage.

Notes:

- The MSHD cannot directly control the motor brake.
- The polarity of the digital output can be altered to make the drive electronics match those of the motor control circuit.

6.11 Motor Phasing

Certain factors that affect the direction of motion, such as motor phase direction, A/B swap, index polarity, and Halls wiring, may be unknown or incorrectly set when the MSHD is connected to the motor for the first time. In addition, motor or feedback parameters, such as the number of poles or encoder resolution, may be incorrectly defined.

To overcome these problems, the Motor Phasing procedure, MOTORSETUP, enables a fast initial connection of the MSHD to the motor.

The procedure involves moving the motor in forced commutation, which does not require feedback. The rotary motor will move forward/backward about two mechanical revolutions, during which it gathers data regarding the state of Hall switches, index position and polarity, order of phases, and feedback resolution per electrical revolution.

Based on the collected data, the drive updates the variables MFBDIR, MPHASE, MPOLES, MENCRES and MENCZPOS, thereby allowing the user to begin working with the selected motor and wiring.

If the procedure fails (that is, the motor cannot be successfully commissioned by changing the drive parameters), the original values of MFBDIR, MPHASE, MPOLES, MENCZPOS and MENCRES will be restored.

Notes:

- Not all parameters are updated by the procedure. It depends on which parameters are in use, as determined by MENCTYPE.
- The value of MICONT is very important, since this value sets the limit for the current used during the procedure.
- At the end of the procedure, motion of more than two revolutions might occur.

This procedure is also started and stopped by using the Verify and Stop buttons in the Motor screen. Refer to the section Motor Selection.

To execute the Motor Phasing procedure, do the following:

1. Disable the drive.
2. Clear any faults in the drive.
3. Enter the command **MOTORSETUP**.
4. Enable the drive.

   The procedure will begin and perform several steps.

   Once the Motor Phasing procedure is initiated (even when the drive is disabled) the 7-segment display shows a flashing A. When the setup finishes successfully, the display returns to its normal state; if the setup fails, the display shows -5.

To cancel the procedure, enter the command **MOTORSETUP 0**

Any parameters that were modified by the MOTORSETUP procedure will be restored to their previous values.

To view the status of the procedure, enter the command MOTORSETUPST.

6.12 Motor Temperature Sensor

The MSHD supports both thermostat (on/off) and thermistor (temperature sensitive resistance) motor temperature sensors.

When the drive detects a motor over-temperature condition, the motor overtemperature fault is latched, and the 7-segment display flashes H.

Several variables define how the drive interfaces and responds to the sensor.

- THERM indicates whether a motor over-temperature fault exists.
- THERMODE defines how the drive responds to a motor over-temperature fault. If the motor does not have a temperature sensor, or if the sensor is not wired, set THERMODE to 3, so that the drive will ignore this fault.

- THERMTYPE indicates whether the sensor is type PTC (positive temperature coefficient) or NTC (negative temperature coefficient). When using a thermostat (on/off motor temperature sensor), set THERMTYPE to 0 to define type PTC.
- THERMREADOUT reads the resistance of the temperature sensor. The motor over-temperature fault detection and clear mechanism is subject to a hysteresis mechanism. The fault will trip when the resistance passes a certain value, and can be cleared only when the resistance drops below a different value. The variables THERMTRIPLEVEL and THERMCLEARLEVEL set the trip level and the clear fault level:
- For a PTC thermistor, the motor over-temperature fault will trip when the resistance is equal to or greater than the THERMTRIPLEVEL. The fault can be cleared when the resistance is equal to or less than the THERMCLEARLEVEL.
- For an NTC thermistor, the motor over-temperature fault will trip when the resistance is equal to or less than the THERMTRIPLEVEL. The fault can be cleared when the resistance is equal to or greater than the THERMCLEARLEVEL.
- If the motor temperature sensor is a thermostat, the resistance is zero in normal state and infinite in fault state.

6.13 Tuning and Testing

ServoStudio provides several methods for modifying and testing parameters that you can use to optimize and evaluate the drive's performance.

6.13.1 Current Control Loop

The basic current control loop tuning is derived from the motor properties and the bus voltage. The Current Loop screen allows you to set additional current loop gains whose use might improve performance.

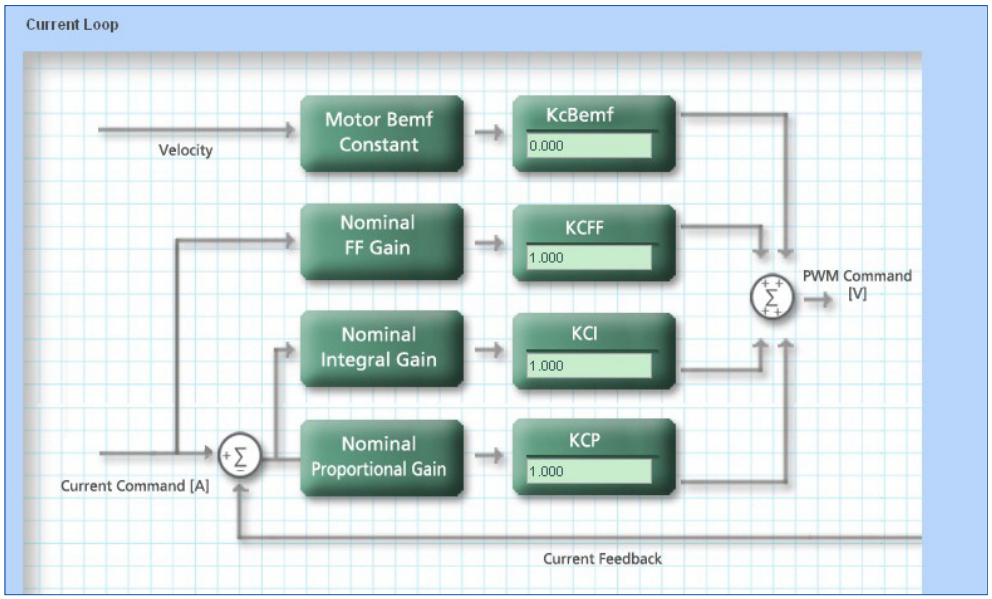


Figure 6-16. ServoStudio – Current Loop Screen

The additional parameters are best set using the current loop autotune function (CLTUNE). Click on the **Current Loop Tuning** button to start this procedure. Use caution, as the motor will turn during this process.

Note: Current loop autotuning is best done with the motor disconnected from any gear and load.

Caution. Current loop tuning causes motion of a few revolutions (for rotary motors) and a few motor pitches (for linear motors). It should not be used for linear motors or rotary motor with movement limitation.

The light blue background in the schematic shows the actual velocity loop. The other elements show pre- and post-processing options.

6.13.2 Velocity Control Loop

Four velocity control loop options are available. In the **Velocity Loop** screen, select the controller method from the list at the top of the screen.

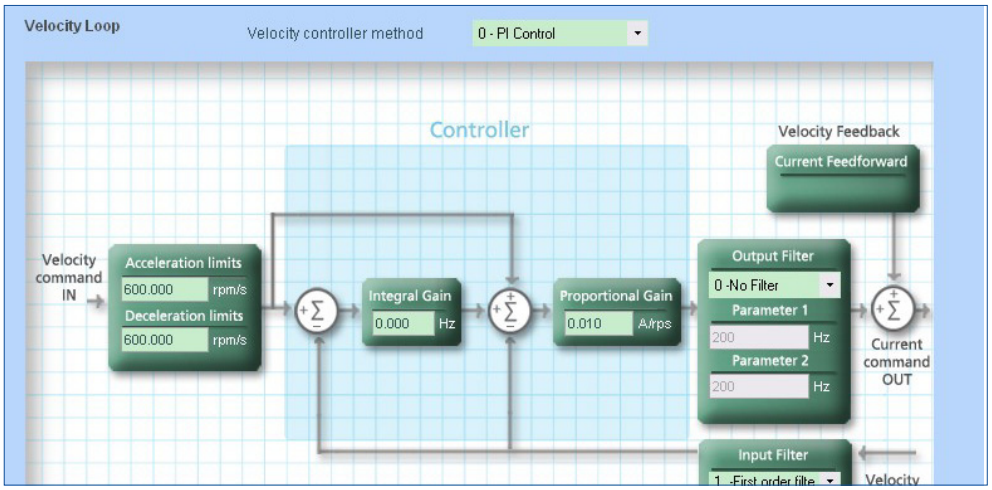


Figure 6-17. ServoStudio – Velocity Loop Screen

The light blue background in the schematic shows the actual velocity loop. The other elements show pre- and post-processing options.

A filter can be applied to the output of the velocity loop. You can choose various options of low-pass, band-pass, high-pass, notch and user-defined filters.

6.13.3 Linear Position Control Loop

Two position control loop options are available, linear and non-linear. In the **Position Loop** screen, select the controller method from the list at the top of the screen.

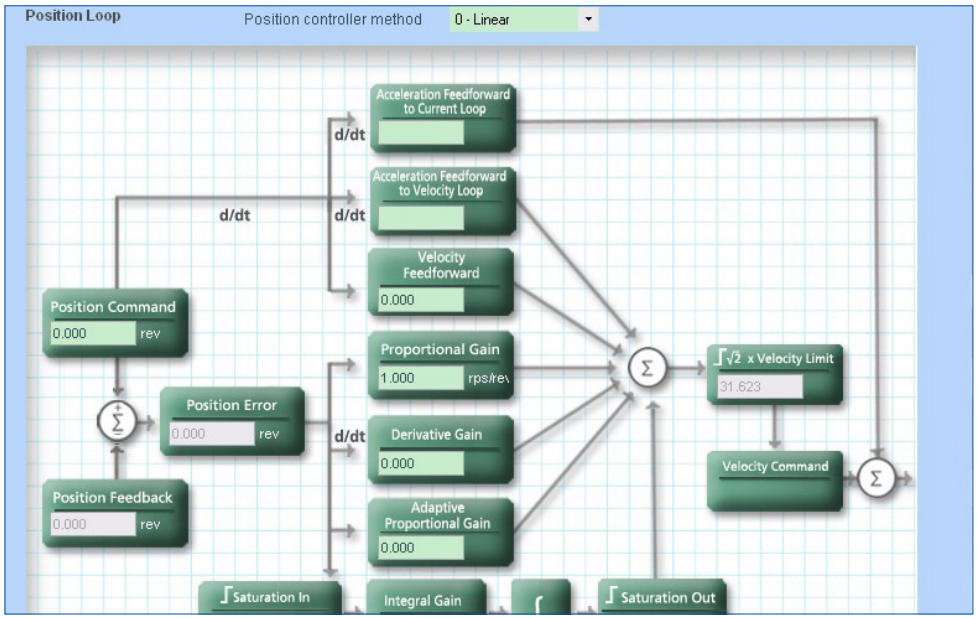


Figure 6-18. ServoStudio – Position Loop – Linear Screen

The Linear Position controller is a PID controller with feedforward, and with the option to limit the integral saturation (anti-windup).

6.13.4 Non-Linear Position Control Loop

The non-linear position (NLP) control algorithm is designed to minimize position error during motion and to minimize settling time at the end of motion.

The NLP controller parameters should be initially set using the Tuning Wizard.

The parameters are shown in the non-linear position control screen, and can be modified as required by the application.

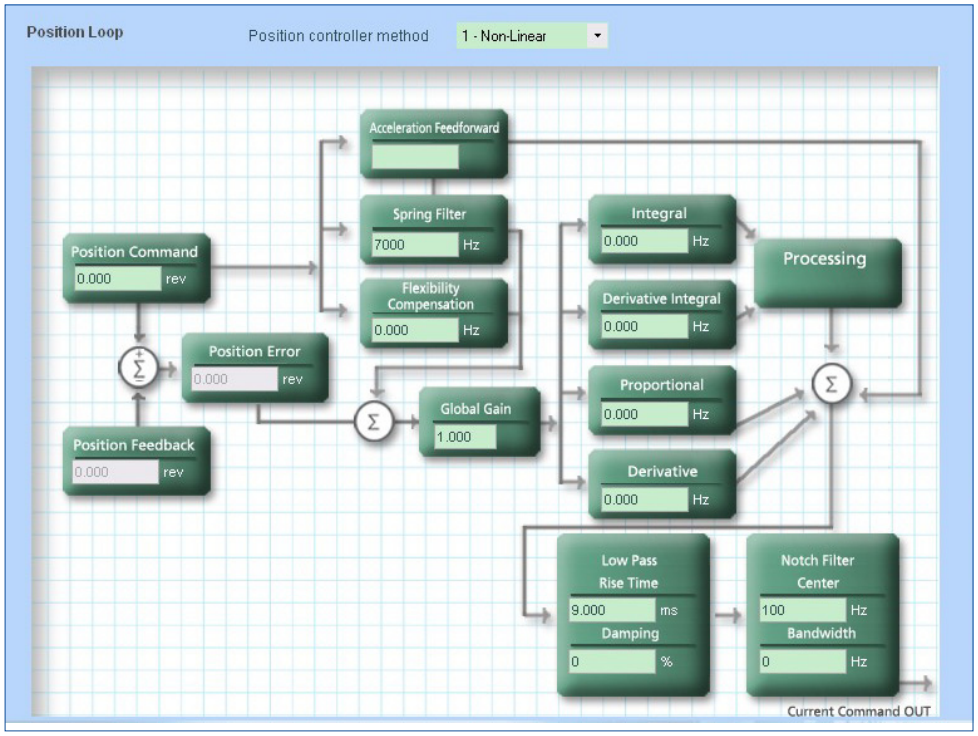


Figure 6-19. ServoStudio – Position Loop – Non-Linear Screen

NLP has four main parallel feedback functions, each of which has a non-linear characteristic. These four functions change dynamically during movement in order to apply the optimal feedback gain while maintaining the stability of the system.

NLP also includes an adaptive feedforward function that is applied at the end of movement in order to achieve a zero or minimum settling time.

Furthermore, NLP provides low pass, notch and other filters to handle flexible and resonant systems.

6.14 Data Recording

ServoStudio provides extensive recording and data graphing capabilities. Recording is done by the drive in real-time, and sent to the host computer for display.

Recording can be set up to be triggered when a specified event or condition occurs. In addition, ServoStudio enables continuous data recording or a one-time recording. ServoStudio also allows execution of a motion command during recording. This is useful, and even necessary, as a tuning tool.

The ServoStudio Scope screen is a dashboard for data recording and graphing.

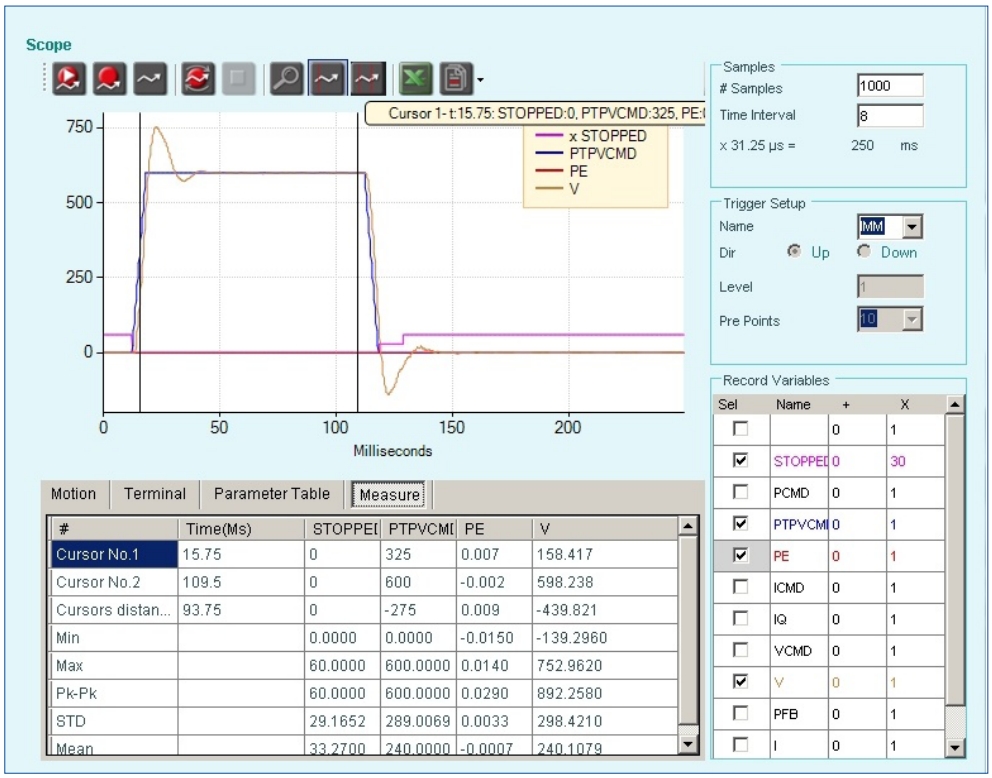


Figure 6-20. ServoStudio – Scope Screen

6.14.1 Recording Setup

The **Recorder Setup** panel, on the right side of the Scope screen, allows you to define the variables and conditions for the data recording.

Samples

# Samples	The total number of points to be recorded. Up to 2000 data points for up to six 32-bit (non-position) variables, or three 64-bit (position) variables, can be recorded simultaneously. Continuously reads and records data from the drive, and displays on screen. Does not have a trigger. Does not have a defined number of sampling points.
Time Interval	The rate at which data is recorded. The interval value is specified in multiples of the drive's basic sampling rate, which is 31.25 µs. For example, an interval of 5 means data is recorded once every 5 samples, that is, every 156.25 µs (5x31.25=156.25).

Record Variables

Name	Name of a variable that can be recorded. Refer to VarCom RECLIST. To add a variable to the list, type the name of the variable in the blank cell in the first row, and press Enter. To define the variables that will actually be recorded, select or clear the check-boxes. Up to six 32-bit (non-position) variables, or three 64-bit (position) variables, can be recorded simultaneously.
+	**Offset** – An offset value on the X-axis that serves to separate overlapping traces on the chart, or to move traces closer together for easier viewing and comparison. Whenever an offset is in effect, a plus sign + is displayed next to the variable name in the legend.
X	**Multiply** – Enlarges a trace that may be too small to view properly because the chart is scaled to the largest value of another variable. Whenever an enlarged trace is in effect, an asterisk * is displayed next to the variable name in the legend.

When using Terminal, the syntax for the comparable VarCom instruction is:

RECORD *[sample time] [num points] [var1] {var2} {var3}*

For example: RECORD 32 100 “VCMD “V “ICMD

Records 100 points for VCMD, V, and ICMD every 1 milliseconds

Note that variables must be preceded by a quotation mark (“).

Trigger Setup

Name	Name of a variable that will trigger the recording. Refer to VarCom RECTRIGLIST. The following variables can also trigger the recording: **IMM** – Starts the recording immediately **CMD** – Starts the recording as soon as the next command is sent to the drive
Direction	Defines whether the trigger occurs when value of the variable goes above the threshold (**Up**) or below the threshold (**Down**).
Level	The threshold value for the trigger.
Pre Points	The number of points to be recorded prior to the trigger point.

When using Terminal, the syntax for the comparable VarCom instruction is:

RECTRIG [var] {level} {pre-trig} {above|below}

Note: If the specified number of pre-trigger points is greater than the number of points actually recorded prior to the trigger, the pre-trigger segment of the recording will include the value of the variable before motion began.

For example, record a Jog (J) that goes to 1000 rpm starting from zero with an acceleration of 10000 rmps/s2; specify the record level at 1 rpm, the direction as Up, 128 pre-trigger points and a time interval of 1. Since there will not be 128 points of pre-trigger motion, the record data will be packed with zeros (zero velocity command before the motion).

6.14.2 Scope Toolbar

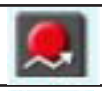
	Move Record and Plot	Executes the command defined in the Motion screen, triggers (and stops) the recording, plots the response and stops the motion.
	Record and Plot	Triggers the recording and plots the response. Does not start or stop the drive.
	Plot	Reads the data last recorded (in the drive), and displays a trace on screen.
	Continuous Record and Plot	Continuously records and displays a trace of the currently defined record data. Does not have a trigger. Does not have a defined number of sampling points. The number of data points and variables that can be recorded depends on several factors. Refer to the section Samples
	Stop Recording	Stops a recording. Aborts the command.
	Toggle Cursor to Zoom	Toggles Zoom In and Zoom Out view of graph. When Zoom In is selected, a minus sign appears on the button. Using the left mouse button, click-and-drag to select an area on the graph for magnification
	Toggle Zoom to Cursor	Cancels the cursor zoom. Hides/displays cursor line/s. When cursor is displayed, use left mouse button to select and position the cursor on the graph. Variable values at the cursor point are displayed in a floating box. Use the Measure tab to view additional variable values at the point marked by the cursor.
	Select Cursor	Displays a second cursor line. Click on the graph to position the second cursor.
	View in Excel	Copies recorded data to a temporary CSV file and opens Microsoft Excel to display it.
	Chart Options	Refer to the section Chart Options.

Chart Options

The options in the Chart Options menu can also be accessed by right-clicking anywhere on the chart.

Clear Chart

Clears the displayed chart.

Chart Properties

Set Background Color	Opens the Colors dialog box, and allows you to modify the background color of the chart.
Grid	Toggles the grid display on and off. Also allows you to modify the grid: X Axis – Toggles the X-axis grid line on/off Y Axis – Toggles the X-axis grid line on/off Dot | Line – Uses either dotted lines or solid lines for the grid.
Show Legend	Toggles the legend display on and off.
Trace Line Type	Allows you to define how the trace line is displayed: Line, Spline or Points.
Freeze Scale	Sets the Y-axis to a fixed scale. Normally the Y-axis is scaled dynamically as the amplitude of the signals changes. When Scale is frozen, the letter F is displayed next to the Chart Options button on the toolbar. When Scale is frozen, the letter O is also displayed if part of the trace is out of view.
Reset All Trace Offsets	Resets the value of all offset (+) values in the Record Variables list to 1. Whenever an offset is in effect, a plus sign + is displayed next to the variable name in the legend.

Hide Trace

Right-click on a specific trace, and select Hide Trace to hide just one trace.

Show All (Hidden) Traces

Displays all traces on the chart that were hidden by the Hide Trace option.

Reference/Previous Set

Show Reference Set	Displays the trace previously saved as a reference.
Show Previous Set	Displays the previously displayed trace in addition to the currently displayed trace.
Save as Reference Set	Saves the trace currently displayed on screen as a reference.
Keep Reference as Background	Keeps the reference trace displayed on screen as a background.
Shift Set Position	Allows you to move a set of traces along the X-axis, to separate overlapping traces on the chart, or to align the trigger points on different traces.

File

Save As	Exports a recording to a CSV file, so that it can be viewed and analyzed in Microsoft Excel.
Load From	Loads recorded data that was saved in a CSV file.

6.14.3 [Motion|Terminal|Parameter Table|Measure] Panel

Motion Tab

Refer to the section Operation Modes.

Terminal Tab

Refer to the section Terminal.

Parameter Table Tab

The Parameter Table displays and allows you to modify a set of variables related to the mode of operation in effect. The mode is shown in the Motion tab.

Measure Tab

The Measure tab presents several measurements from the data currently displayed in the chart.

The values displayed change as you drag the cursors to different locations on the chart.

Cursor No.1	X-axis = time (in ms); value of trace at the point crossed by cursor.
Cursor No.2	X-axis = time (in ms); value of trace at the point crossed by cursor.
Cursor Distance	Time difference between the two cursors. (Cursor 2 - Cursor 1)
Max	Highest recorded value in the trace.
Min	Lowest recorded value in the trace.
Pk-Pk	The total span, between the highest and lowest recorded values in the trace.
STD	The standard deviation of the trace.
Mean	The mean value of the trace.

6.14.4 Recording Data Using VarCom Instructions (Terminal)

To record data in the MSHD, perform the following steps:

1. Use the command RECORD to define the variables to be recorded, the recording interval, and the number of points to record.
2. Use the command RECTRIG to define the variable and conditions that triggers the recording.
3. Use the variable RECDONE (recording finished) and/or RECING (recording in progress) to determine whether recorded data is available.
4. Set variable GETMODE to 0. Then use the command GET to retrieve the recorded data in a comma-separated variable (CSV) ASCII format.

Activation Commands

- RECORD defines the variables to be recorded and the recording time span and sample time.
- RECTRIG defines the triggering condition for starting a recording, and also pre-trigger duration.
- RECOFF turns active recording off.

Utility Information

- RECLIST lists all the variables that can be recorded by the record function.
- RECTRIGLIST lists all the options for triggering the recording.

Status Flags

- RECRDY indicates that a recording is armed and ready.

- RECING indicates that a trigger condition has occurred and that a recording is active.
- RECDONE indicates that the recording is completed

Data Retrieval

- GETMODE defines the format for the recorded data (binary/ASCII)
- GET retrieves the recorded data

7 Firmware Upgrade

The MSHD firmware can be upgraded using the ServoStudio software.

7.1 Preparation

Important: Before upgrading the firmware, do the following:

- Backup the drive parameters since parameter settings may be lost during the upgrade. After the upgrade is completed, the parameters can be reloaded/restored.

  To backup parameters from ServoStudio, go the **Backup & Restore** screen, and click the **Backup** button. Refer to Managing Parameters.
- Read the release note or other documentation supplied with the new firmware.

7.2 Ember Mode

Ember is the process used for burning new firmware on the drive's flash memory. The drive must be in the Ember mode for the firmware to be loaded. The MSHD has two Ember modes, Software and Hardware.

Normally, you can and should communicate with the drive in Software Ember mode for loading new firmware.

However, if the firmware loading process has been interrupted and you are unable to establish communication with the drive, you need to use the Ember Hardware mode.

To activate the Hardware Ember mode, use a small screwdriver or similar tool to press the Hardware Ember switch. This switch is located on the top of the drive next to the daisy chain connector (C8). Refer to Figure 7-1.

Pressing the switch sets the drive to serial communication Boot-Up Mode. All segments on the front panel 7-segment LED display light up, and (if it exists) the fan rotates at maximum speed. The fan speed will revert to normal after the firmware has been downloaded successfully and the drive has restarted.

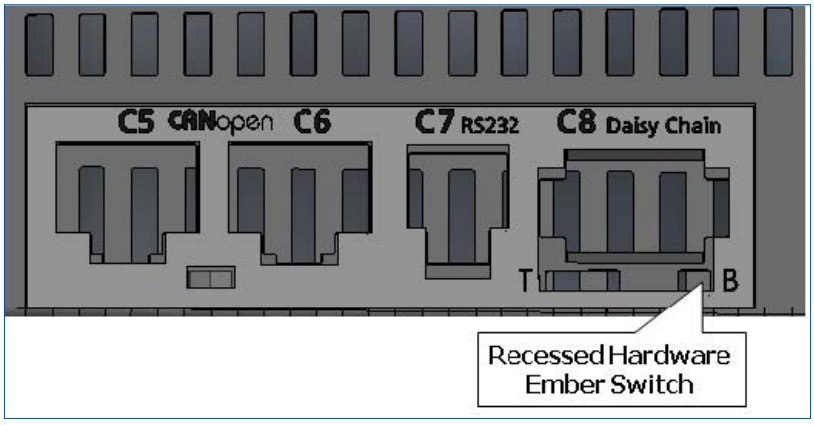


Figure 7-1. Location of Hardware Ember Switch

7.3 Upgrade Procedure

1. From the ServoStudio Drive Info screen, click Download Firmware.

The Ignite dialog box opens. Ignite manages the download of firmware to the drive. It downloads the firmware file to the drive over a USB or RS232 serial communications link.

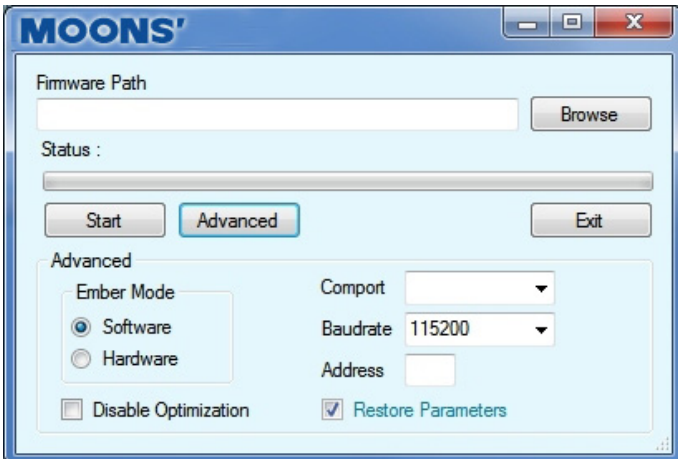


Figure 7-2. Firmware Upgrade Interface

2. Browse to and select the firmware file, and press Start.

Alternately, click Advanced to expand the dialog box and modify settings.

Then press Start to begin the firmware upgrade process.

Firmware Path	The path and name of the file containing the firmware upgrade. My Documents/ ServoStudio.
Ember Mode	Ember is the process used for burning new firmware on the drive's flash memory. Software: Normally use the default Software option. Hardware: If the firmware loading process has been interrupted and you are unable to establish communication with the drive, use this option. Refer to the section Ember Mode.
Com Port	The COM port of the host computer to which the MSHD is connected. Make sure this COM port is not being used by any other application.
Baud Rate	The rate must be set to 115200.
Address	When only one drive is connected to the host computer, a drive address is not needed. Ignite attempts to communicate with the drive that was communicating with the host before Ignite was launched. Thus, if the drive responds to serial communication, Ignite will begin the firmware download. When multiple drives are connected to the host in a daisy-chain, a drive address must be specified. When a drive address is specified, Ignite starts by sending the command \\ which stops all drives connected to the selected serial port from responding to serial communication. It then issues the command \nn which instructs only the drive with address nn to respond. Then it begins the firmware download.
Disable Optimization	Ignite uses an optimization method to improve performance. In rare instances this optimization may cause the procedure to fail. In such an instance, disable the optimization and restart the firmware upgrade.

Restore Parameters	Ignite stores all user parameters to memory before downloading the firmware and restores the parameters after the upgrade. This option can be disabled. This option is not available if host and drive are not communicating

During the firmware upgrade process, the 7-segment LED display shows a steadily-lit E.

When the process is complete, click the Exit button.

Ignite automatically restarts the MSHD when the firmware download process is complete.

7.4 Resuming Operation

1. Go to the ServoStudio Drive Info screen in ServoStudio, and check the drive firmware version to verify that the new firmware has been loaded.
2. If the drive parameters were not restored by the Ignite program, go the ServoStudio Backup & Restore screen, and click the Restore button.
3. Check the version release note, and set any parameters that may have been added to the new version.
4. Save the parameters to the non-volatile parameter memory: either execute the SAVE command over the serial port, or click the Save button on the ServoStudio toolbar.8 Troubleshooting

8 Troubleshooting

8.1 Faults and Warnings

If the MSHD is connected to a host computer via the USB or RS232 ports, it communicates fault codes to the computer by means of a text message. This message is saved in a fault history log (FLTHIST) in the drive's non-volatile memory, so that the fault history is not lost when power is removed from the drive.

- Warnings are not considered faults and do not disable operation. The system automatically clears the warning state when the condition that generated the warning no longer exists.
- Faults occur when settings or conditions may cause improper operation of the drive/motor and/or equipment damage. Faults automatically disable the drive, and a fault status is indicated on the drive's display and in the software interface. The drive fault status is generally latched, and the drive cannot be enabled until the fault status is explicitly cleared. Only if the fault condition no longer exists can the fault status be cleared. It is done by either of the following:
    - Toggling the drive enable. This is done either by executing a drive disable command (K) followed by the enabled (EN) command or by toggling the Remote Enable line (REMOTE).
    - In some systems, a specific drive input is defined as Alarm Clear. In this case, toggling this input will clear the fault.
- Some faults are referred to as fatal faults since they disable almost all drive functions (including communications) and prevent the drive from being enabled. This condition is typical of faults due to internal failures, such as a watchdog event or a failure of an internal power source. Fatal faults require intervention by technical support.

8.2 Fault & Warning Indicators

The ServoStudio status bar continuously shows the status of the drive.

Faults	This segment of the status bar is green as long as no faults exist; it is red whenever a fault exists. Click Faults to open the Enable & Faults screen.
Warnings	This segment of the status bar is green as long as no warnings exist; it is yellow whenever a warning exists. Click Warnings to open the Enable & Faults screen.
Messages	Notifications from ServoStudio about conditions that require attention. Click Messages to see the full text.

The ServoStudio Enable & Faults screen has a Faults panel. This panel has two tabs:

- **Faults & Warnings:** Shows a list of faults that are preventing the drive from being enabled. Alternately, the variable FLT returns a list of faults latched by the drive. Faults remain latched until cleared by CLEARFAULTS or EN, provided that the fault condition has been removed.

• **Fault History:** Shows a list of faults that have occurred since the fault buffer was last cleared. Alternately, the variable FLTHIST returns this list; FLTHISTCLR clears the fault history buffer.Each tab presents the following information:

Icon	A graphic image that indicates the type of fault: Warning, Fault, Fatal Fault.
Display	In Faults & Warnings tab only. A graphic replica of the code that appears on the drive's 7-segment display.
Time	In Fault History tab only. The internal runtime at which the fault occurred.
Fault Name	The system name of the fault.
Description	Describes the status or fault indicated by the code.
Action Required	Describes the recommended steps for correcting the fault.

8.3 Drive Status 7-Segment Display

The 7-segment display provides various indications of drive status, such as operation modes, drive enable status, and fault conditions.

In general, the display uses the following conventions:

- Decimal point – indicates the drive's Enable/Disable status; if displayed, the drive is enabled.
- Steadily lit digit – indicates the operation mode (OPMODE) currently in effect.
- Steadily lit letter – indicates a warning.
- Sequential display of letters and digits – indicates a fault (except for At1 and At2) Other Status Indications
- A t 1 displayed in sequence indicates motor phasing (MOTORSETUP) is in progress.
- A t 2 displayed in sequence indicates current loop autotuning (CLTUNE) is in progress.
- A digit flashing at half-second intervals during encoder initialization, indicates the operation mode (OPMODE) currently in effect.

In the event of concurrent faults, only one fault code is displayed on the 7-segment display. The display shows the code of the fault with the highest priority.

The 7-segment code descriptions are presented here in alphanumerical order, in the following format:

picture of code	code in text	How displayed (e.g., flashing)
	Definition	Short name. Used in ServoStudio.
	Type	Specifies the type of status or fault indicated by the code: **Mode, Warning, Fault or Fatal fault.**
	Active disable	Indicates whether the Active Disable function (part of Disable mode) can be triggered by the fault.
	Description	Describes the status or fault indicated by the code.
	Action required	Describes the recommended steps for correcting the fault.

	=	Flashing
	Definition	Watchdog Fault
	Type	Fault
	Active disable	No
	Description	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled
	Action required	Contact technical support

	-	
	Definition	Watchdog Fault
	Type	Fault
	Active disable	No
	Description	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled
	Action required	Contact technical support

	-1	Displayed in sequence
	Definition	Not Configured
	Type	Fault
	Active disable	Not applicable
	Description	Drive configuration required.
		CONFIG is required after the value of any of the following parameters is modified: DICONT DIPEAK DIR KCBEMF KCDQCOMP KCFF KCFFSAT KCI KCP KCPISAT KCSAT MENCRES MENCTYPE MFBDIR MFBMODE MICONT MIPEAK MKF MKT ML MLGAINC MLGAINP MOTORTYPE MPITCH MPOLES MRESPOLES MSPEED VBUS CONFIG is also required after any of the following parameters is sent to the drive, even if its value has not been changed: FEEDBACKTYPE MVANGLF MVANGLH PWMFRQ VLIM
	Action required	Set drive parameters and/or and execute CONFIG.

	-5	Displayed in sequence
	Definition	Motor Setup Failed
	Type	Fault
	Active disable	No
	Description	Motor Setup procedure failed. MOTORSETUPST will show the cause.
	Action required	Check phase and motor wiring. Make sure the correct feedback type is selected. Check MOTORSETUPST for hints.

	-6	Displayed in sequence
	Definition	Current Loop Autotune Failed
	Type	Fault
	Active disable	No
	Description	One of the steps in the Current Loop Autotune process has failed.
	Action required	Check CLTUNEST for the failed step.

	0	Lit steadily
	Definition	Serial Velocity Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	1	Lit steadily
	Definition	Analog Velocity Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	2	Lit steadily
	Definition	Serial Current Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	3	Lit steadily
	Definition	Analog Current Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	4	Lit steadily
	Definition	Gearing Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	8	Lit steadily
	Definition	Profile Position Mode
	Type	Mode
	Active disable	Not applicable
	Description	Not applicable
	Action required	Not applicable

	A4	Displayed in sequence
	Definition	CAN Supply Fault
	Type	Fault
	Active disable	Yes
	Description	A problem with the internal voltage supply for the CANbus
	Action required	The drive probably needs repair. Contact technical support

	At1	Displayed in sequence
	Definition	Motor Setup in Progress
	Type	Mode
	Active disable	Not applicable
	Description	The Motor Phasing procedure is in progress. If the procedure fails, the display will show “-5”.
	Action required	Not applicable

	At2	Displayed in sequence
	Definition	Current Loop Tuning in Progress
	Type	Mode
	Active disable	Not applicable
	Description	The Current Controller Loop Autotuning procedure is in progress. This procedure actively tests and modifies the variables KCP, KCI, KCFF, KCBEMF. If the procedure fails, the display will show “-6”.
	Action required	Not applicable

	b	Flashing
	Definition	Drive Locked
	Type	Fatal fault
	Active disable	Not applicable
	Description	Security code and key do not match. Drive cannot be operated.
	Action required	Contact technical support

	b1	Flashing
	Definition	PLL (Phase-Locked Loop) Synchronization Failed
	Type	Fault
	Active disable	No
	Description	Controller synchronization signal is missing or not stable. The fault is detected only when synchronization is enabled by SYNCSOURCE command.
	Action required	Check for controller synchronization signal. Check the cable connection and wiring.

	C1	Displayed in sequence
	Definition	CAN Heartbeat Lost
	Type	Fault
	Active disable	Yes
	Description	Drive identified a disconnection in CAN master/drive connection.
	Action required	Reconnect master/slave connection and power cycle the drive.

	e	Flashing
	Definition	Parameter's Memory Checksum Failure
	Type	Fault
	Active disable	Not applicable
	Description	The non-volatile memory used to store drive parameters is empty or the data is corrupted.
	Action required	Reconfigure the drive, or download the parameter set, and save the parameters.

	E	Flashing
	Definition	Failure Writing to Flash Memory
	Type	Fatal fault
	Active disable	Not applicable
	Description	An internal problem accessing the flash memory. Drive cannot be operated.
	Action required	Contact technical support.

	E	Lit steadily
	Definition	Ember Mode
	Type	Mode
	Active disable	Not applicable
	Description	Firmware is being updated in the drive.
	Action required	Not applicable

	e101	Displayed in sequence
	Definition	FPGA Config Fail
	Type	Fatal fault
	Active disable	Not applicable
	Description	The code for the FPGA did not load. Drive cannot be operated.
	Action required	Contact technical support.

	e105	Displayed in sequence
	Definition	Self Test Fail
	Type	Fatal fault
	Active disable	Not applicable
	Description	The power-up self test failed. Drive cannot be operated.
	Action required	Contact technical support.

	e106	Displayed in sequence
	Definition	Control EEPROM Fault
	Type	Fatal fault
	Active disable	Not applicable
	Description	A problem accessing the EEPROM on the digital board. Drive cannot be operated.
	Action required	Contact technical support.

	e107	Displayed in sequence
	Definition	Power EEPROM Fault
	Type	Fatal fault
	Active disable	Not applicable
	Description	A problem accessing the EEPROM on the power board. Drive cannot be operated.
	Action required	Contact technical support.

	e108	Displayed in sequence
	Definition	Vbus Measure Circuit Fail
	Type	Fault
	Active disable	Yes
	Description	A failure occurred in the circuit that measures bus voltage.
	Action required	Reset faults. If the fault persists, the drive probably needs repair. Contact technical support.

	e109	Displayed in sequence
	Definition	Current-Sensors Offset Out-of-Range
	Type	Fault
	Active disable	No
	Description	The calculated offsets for the current sensors are out of range.
	Action required	Reset faults. If the fault persists, the drive probably. needs repair. Contact technical support

	F	Lit steadily
	Definition	Foldback Warning
	Type	Warning
	Active disable	Not Applicable
	Description	Drive average current exceeds rated drive continuous current. Current foldback is active.
	Action required	Check the drive-motor sizing. This warning can occur if the drive is under-sized (under-powered) for the application.

	F1	Displayed in sequence
	Definition	Drive Foldback
	Type	Fault
	Active disable	Yes
	Description	Drive average current exceeds rated drive continuous current. It occurs after the Foldback warning has occurred.
	Action required	Check motor-drive sizing. This warning can occur if the drive is under-sized (under-powered) for the application. Check that the commutation angle is correct (i.e., commutation is balanced).

	F2	Displayed in sequence
	Definition	Motor Foldback
	Type	Fault
	Active disable	Yes
	Description	Motor average current exceeds rated motor continuous current. It occurs after the Foldback warning has occurred.
	Action required	Check the drive-motor sizing. This warning can occur if the motor is under-sized (under-powered) for the application.

	H	Flashing
	Definition	Motor Over-Temperature
	Type	Fault
	Active disable	Yes
	Description	Either the motor has overheated, or the drive is not set up correctly for the motor temperature sensor.
	Action required	Check that the drive is configured properly (using THERMODE, THERMTYPE, THERMTHRESH and THERMTIME), and that the motor temperature sensor is properly connected to the drive if needed. If the drive is configured and wired properly, check whether the motor is under-sized for the application.

	j	Flashing
	Definition	Velocity Over-Speed Exceeded
	Type	Fault
	Active disable	Yes
	Description	Actual velocity exceeded 1.2 times the velocity limit. The velocity limit is set using VLIM.
	Action required	Check that VLIM is set to match the application requirements. Using velocity loop tuning, check for excessive overshoot.

	j1	Displayed in sequence
	Definition	Exceeded Maximum Position Error
	Type	Fault
	Active disable	Yes
	Description	The position error (PE) has exceeded the position error limit (PEMAX)
	Action required	Change drive tuning to improve position tracking, or increase PEMAX to allow a greater position error.

	n	Flashing
	Definition	STO Fault
	Type	Fault
	Active disable	No
	Description	The STO signal is not connected.
	Action required	Check that the STO connector (P1) is wired correctly.

	n1	Displayed in sequence
	Definition	Regen Over-Current
	Type	Fault
	Active disable	Yes
	Description	The preset current limit for regen current has been exceeded.
	Action required	Increase the value of the regen resistor.

	n2	Displayed in sequence
	Definition	Brake Fault
	Type	Fault
	Active disable	Yes
	Description	
	Action required	

	o	Flashing
	Definition	Over-Voltage
	Type	Fault
	Active disable	No
	Description	The bus voltage exceeded the maximum value.
	Action required	Check whether a regen resistor is required for the application.

	o15	Displayed in sequence
	Definition	Plus 15V Out of Range
	Type	Fault
	Active disable	Yes
	Description	The internal +15 V supply is out of range.
	Action required	The drive probably needs repair. Contact technical support.

	o-15	Displayed in sequence
	Definition	Minus 15V Out of Range
	Type	Fault
	Active disable	Yes
	Description	The internal -15 V supply is out of range.
	Action required	The drive probably needs repair. Contact technical support.

	P	Flashing
	Definition	Over-Current
	Type	Fault
	Active disable	No
	Description	Over-current at the drive output has been detected. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled.
	Action required	Check for a short circuit on the motor connection. Check for excessive overshoot in the current loop.

	r10	Displayed in sequence
	Definition	Sine Feedback Communication Fail
	Type	Fault
	Active disable	No
	Description	Communication problem between the drive and the EnDat encoder.
	Action required	Check that the data and clock signals to the EnDat encoder are connected properly. The cable must be shielded.

	r14	Displayed in sequence
	Definition	Sine Encoder Quadrature Fault
	Type	Fault
	Active disable	No
	Description	Mismatch between calculated and actual encoder quadrature information.
	Action required	Check the feedback device wiring. Make sure the correct encoder type (MENCTYPE) is selected.

	r15	Displayed in sequence
	Definition	Sin/Cos Calibration Invalid
	Type	Fault
	Active disable	No
	Description	The sine/cosine calibration parameters are out of range. This fault is related to resolver and sine encoder feedback
	Action required	Re-execute the sine/cosine calibration process.

	r16	Displayed in sequence
	Definition	Feedback 5V Over-Current
	Type	Fault
	Active disable	No
	Description	The current supplied by the drive on the 5V primary encoder supply has exceeded the preset current limit. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled.
	Action required	The MSHD can source a maximum current of 250 mA to the primary encoder. Check for a short-circuit at the encoder. Check if the encoder is drawing more than the current limit

	r17	Displayed in sequence
	Definition	Secondary Feedback Index Break
	Type	Fault
	Active disable	Yes
	Description	Secondary encoder index line not connected..
	Action required	Check whether the drive is configured for working with the index signal on the secondary encoder, and check if the index signal is connected.

	r18	Displayed in sequence
	Definition	Secondary Feedback A/B Line Break
	Type	Fault
	Active disable	Yes
	Description	One of the secondary feedback signals is not connected.
	Action required	Check that all signals from the secondary encoder are properly connected to the drive.

	r19	Displayed in sequence
	Definition	Secondary Feedback 5V Over-Current
	Type	Fault
	Active disable	Yes
	Description	The preset current limit for current supplied by the drive on the 5 V secondary encoder supply has been exceeded.
	Action required	The MSHD can source a maximum current of 250 mA to the secondary encoder. Check for a short-circuit at the encoder. Check if the encoder is drawing more than the current limit.

	r20	Displayed in sequence
	Definition	Feedback Communication Error
	Type	Fault
	Active disable	No
	Description	Communication with the feedback device did not initialize correctly.
	Action required	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

	r21	Displayed in sequence
	Definition	Sanyo Encoder Operational Fault
	Type	Fault
	Active disable	No
	Description	Communication with the Sanyo Denki feedback device did not initialize correctly.
	Action required	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

	r23	Displayed in sequence
	Definition	Phase Find Failed
	Type	Fault
	Active disable	No
	Description	Commutation initialization has failed. This fault occurs in systems that do not have commutation information (e.g., Hall signals) in the motor feedback device.
	Action required	Check whether the motor feedback type and the phase-finding parameters are set correctly for the application.

	r24	Displayed in sequence
	Definition	Tamagawa Init Failed
	Type	Fault
	Active disable	No
	Description	The initialization process with the Tamagawa feed-back device has failed.
	Action required	Check that the wiring to the encoder is correct.

	r25	Displayed in sequence
	Definition	Pulse & Direction Input Line Break
	Type	Fault
	Active disable	No
	Description	One of the Pulse & Direction signals is not connected.
	Action required	Check that all signals to the P&D inputs are properly connected to the drive.

	r26	Displayed in sequence
	Definition	Tamagawa Abs Operational Fault
	Type	Fault
	Active disable	No
	Description	Several faults are indicated by the feedback device and include one or more of the following: battery low/ error, over-speed, counting error, multi-turn error.
	Action required	Check the battery voltage and feedback wiring. Make sure the motor did not move at a high velocity during encoder initialization.

	r27	Displayed in sequence
	Definition	Motor Phases Disconnected
	Type	Fault
	Active disable	Yes
	Description	One of the motor phases is disconnected. The current of one of the motor phases is effectively zero for more than 160 electrical degrees while the current com-mand is greater than 100.
	Action required	Check the wiring of the motor phases.

	r28	Displayed in sequence
	Definition	Resolver Initialization Failed
	Type	Fault
	Active disable	No
	Description	The drive could not detect the proper gain setting or sampling point for the sine/cosine signals.
	Action required	Check resolver wiring and gain value.

	r4	Displayed in sequence
	Definition	A/B Line Break
	Type	Fault
	Active disable	No
	Description	One of the primary feedback signals is not connected. This fault occurs in incremental encoder, resolver and sine encoder feedback types.
	Action required	Check whether all signals from the primary feedback device are properly connected to the drive.

	r5	Displayed in sequence
	Definition	Index Line Break
	Type	Fault
	Active disable	Yes
	Description	Encoder index line is not connected
	Action required	Check that the drive is configured for working with the index signal (using MENCTYPE), and check if the index signal is connected.

	r6	Displayed in sequence
	Definition	Illegal Halls
	Type	Fault
	Active disable	Yes
	Description	The drive has detected either 000 or 111 state on the Hall feedback signals.
	Action required	Check that the Hall signals are all properly connected. While turning the motor, read the Halls state (using HALLS) to see which signal is not connected. If the feedback type is Tamagawa, check that the feedback wiring is correct

	r8	Displayed in sequence
	Definition	A/B Out of Range
	Type	Fault
	Active disable	No
	Description	Feedback analog signal is out of range. This fault is related to resolver and sine encoder feedback. The drive checks that the amplitudes of the sine and cosine signals are correct, based on the calculation sin2 + cos2 = 1
	Action required	Check the amplitudes of the sine and cosine signals.

	r9	Displayed in sequence
	Definition	Encoder Simulation Freq Too High
	Type	Fault
	Active disable	Yes
	Description	The computed equivalent encoder output frequency exceeds the upper limit for this signal, which is 4 MHz.
	Action required	Check the parameters used for setting up the equivalent encoder output. If using a sine encoder, check the ENCOUTRES parameter settings.

	t	Lit steadily
	Definition	Over-Temperature
	Type	Warning
	Active disable	Not Applicable
	Description	The temperature on the power board and/or on the control board has exceeded the preset limit.
	Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

	t1	Displayed in sequence
	Definition	Power Stage Over-Temperature
	Type	Fault
	Active disable	Yes
	Description	The temperature on the power board has exceeded the preset limit.
	Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

	t2	Displayed in sequence
	Definition	IPM Over-Temperature
	Type	Fault
	Active disable	Yes
	Description	The temperature within the integrated power module has exceeded the preset limit.
	Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

	t3	Displayed in sequence
	Definition	Control Board Over-Temperature
	Type	Fault
	Active disable	Yes
	Description	The temperature on the control board has exceeded the preset limit
	Action required	Check if the ambient temperature exceeds the drive specification. Otherwise contact technical support.

	u	Lit steadily
	Definition	Under-Voltage
	Type	Warning
	Active disable	Not Applicable
	Description	The bus voltage is below the minimum value. If the value of variable UVMODE is 1 or 2, and the drive is enabled, an under-voltage warning is issued.
	Action required	Check that the main AC voltage supply is connected to the drive and is switched on. The under-voltage limit can be read with the UVTHRESH command.

	u	Flashing
	Definition	Under-Voltage
	Type	Fault
	Active disable	No
	Description	The bus voltage is below the minimum value. If the value of variable UVMODE is 3, and the drive is enabled, an under-voltage fault is issued.
	Action required	Check that the main AC voltage supply is connected to the drive and is switched on. The under-voltage limit can be read with the UVTHRESH command.

9 Appendix: Scripting

9.1 ServoStudio Scripts

ServoStudio includes a simple scripting language that allows the MSHD to perform logical and control tasks that can run independently and simultaneously.

A script may contain any number of commands. A command may be either a drive command (i.e., a VarCom instruction; refer to the VarCom Reference Guide) or a script command, as described in this Appendix.

Any number of script files can be stored on the host computer and opened in ServoStudio. Scripts are stored as text files, which can also be edited in Notepad or any other text editor.

Multiple scripts can be executed concurrently. Each script is executed in its own thread, so that other program functions, such as Terminal, Scope and Watch, can be simultaneously active for any number of scripts.

9.2 Syntax and Special Characters

#	Defines the start of a script command.
$	Prefix for all variable names. A variable name begins with the character $ followed by any combination of letters and digits.
+ - * /	Operators – add, subtract, multiply, divide.
< > ==	Condition operators – less than, greater than, equal to, not equal to
=	Assigns a value to a variable; for example: #Var $Pos = 3 $Pos = $Pos + 1
;	Marks the beginning of a comment. Can be inserted anywhere in the line. All text after the ; until the end of the line is ignored. Comment text is displayed in green.
{ }	Brackets delineate a string of two or more arguments (tokens), which are thus sent to the drive as a single entity. The script engine can handle only 3 variables.
@	Replaces name of a variable with an address from a map file (MSHD.map)

9.3 Variables

A variable is defined by an assignment statement:

<VarName> = *<Value>* *<Operator>* *<Value>*

Where <Value> is a variable name, drive command, or decimal number.

Variable values can be the output of drive command or the result of a calculation.

These values can be compared in a condition statement:

<Condition> = *<Value>* *<Condition Operator>* *<Value>*

Where <Condition> is if or while

9.4 Commands

The following commands are recognized by the ServoStudio script engine.

Var

Syntax	#Var $<VarName> #Var $<VarName> = <Value>
Variables	$<VarName> = variable name <Value> = number or drive parameter name
Operation	Declares the variable. Declares the variable and sets its initial value.

Label

Syntax	#Label <LabelName>
Variables	<LabelName> = the label name
Operation	Sets a label to be referred to by #If and #Goto commands.

Goto

Syntax	#Goto <LabelName>
Variables	<LabelName> = the name of the label for the #Goto
Operation	Jumps to the label name

If

Syntax	#If <Condition> <Label_Name>
Variables	<Condition> = can be < > == != <LabelName> = the name of the label for the #Goto
Operation	Evaluates a condition; if true, jumps to the label name.

While

Syntax	#While <Condition> … #End_While
Variables	<Condition> = can be < > == !=
Operation	Repeats all commands between #While and #End_While, as long as the condition is true. The #While block may include any script commands, including any number of nested #While blocks.

Message

Syntax	#Message <VarName_1> [<VarName _2>]
Variables	<VarName _1> <VarName _2> = can be a script variable, drive command or text string
Operation	Opens message box to display the value of the variables, and pauses execution of the script until user clicks OK.

Print

Syntax	#Print <Var_1> [<Var_2>]
Variables	<Var_1> <Var_2> = can be a script variable, drive command or text string
Operation	Prints the value of the variable/s to the Output panel.

Plot

Syntax	#Plot
Operation	Plots a graph using recorded data from the drive. This is the same as pressing the Plot button on Scope screen toolbar.

SavePlotFile

SavePlotFile

Syntax	#SavePlotFile [<Filename>] #SavePlotFile [$<Name>]
Variables	<Filename> = name of a file; if not specified, a default name is used $<VarName> = a script variable; enables saving multiple files in the same script
Operation	Saves data from the currently displayed Scope screen to a CVS file.

Delay

Syntax	#Delay <Var>
Variables	$<VarName> = a number or a variable
Operation	Pauses execution of the script for the specified number of milliseconds.

ClearOutput

Syntax	#ClearOutput
Operation	Clears the contents of the Output panel

9.5 Sample Scripts

Example 1 – Record a Motion

```
k
opmode 0
VELCONTROLMODE 0
acc 5000
dec 5000
kvp 1
kvi 0
en
record 16 1000 "vcmd "v "iq
rectrig "imm
j 500
#Delay 200
j 0
#Delay 200
k
#Plot
```

Example 2 – Set Outputs According to Input

```
; Toggle_out.txt script
;
; First, the script checks state of digital input 7
; if digital input 7 equal to 1 then
; the script will toggle one by one
; digital outputs from output 4 to 6
; Digital outputs setup
```

```
#Print .........Digital_outputs_init
outmode 4 0
outmode 5 0
outmode 6 0
outinv 4 0
outinv 5 0
outinv 6 0
; Digital input setup
#Print .........Digital_input_7_init
inmode 7 0
ininv 7 0
; Initialize output number counter
#Var $out_n
$out_n=4
; Infinite loop
#While 1>0
#If {in 7} <1 end_loop
out $out_n 1
#Print outputs
#Delay 500
out $out_n 0
$out_n= $out_n + 1
#If $out_n> 6 reset_out_n
#Goto end_loop
#Label reset_out_n
$out_n = 4
#Label end_loop
#End_While
```

Example 3 – Set Speed According to Inputs

```
; Toggle_velocity.txt script
;
; The script checks state of digital inputs 7,8
; and sets drive speed accordingly
; IN 7 | IN 8 | V
; 0 | 0 | 0
; 1 | 0 | 200
; 0 | 1 | -200
; 1 | 1 | 0

; Digital input setup
#Print .........Digital_Inputs_Setup
inmode 7 0
inmode 8 0
ininv 7 0
ininv 8 0

; Variable for digital input 7,8 state
#var $in_state
#var $in_7
#var $in_8
```

```
; Enter the drive to serial velocity loop
k
opmode 0
en
; Infinite loop
#While 1>0
; Read state of in 7 and in 8
$in_7 = {in 7}
$in_8 = {in 8}*2
$in_state =$in_7+$in_8
#If $in_state == 0 jog_zero
#If $in_state == 1 jog_positive
#If $in_state == 2 jog_negative
#Label jog_zero
#Print JOG_zero
j 0
#Goto end_loop

#Label jog_positive
#Print JOG_plus_200
j 200
#Goto end_loop

#Label jog_negative
#Print JOG_minus_200
j -200

#Label end_loop
#Delay 500
#End_While
```

Example 4 – Set Position Feedback to Zero (Forced Homing)

```
pfboffset 0 ;Clear position offset
#Print pfboffset ;Print position offset
pfboffset = -pfb ;Assign the inverse value of actual position
; (PFB) to the position offset
#Print pfboffset ;Print the new value of position offset
```

10 Appendix: MSHD Serial Communication Protocol

The serial communication link enables the MSHD digital drive and host (terminal, PC, or high-level controller) to communicate using ASCII-coded messages transmitted over an asynchronous, multi-drop line.

When the host and MSHD are communicating through serial communication, a set of commands and variables, called VarCom, are used to configure, control and monitor the drive.

The communication interface can be a graphical software interface, such as ServoStudio, or a user-designed application, or a basic terminal.

10.1 General Information

Specifications

Communications port	RS-232, USB
Baud rate	115200 bits per second (bps)
Start bits	1
Data bits	8
Stop bits	1
Parity	None
Hardware handshake	None
Software handshake	None
Character	ASCII code
Data error check	8-bit checksum

Control Code Definitions

Name	Symbol	Hex
Line feed	<LF>	0Ah
Carriage return	<CR>	0Dh
Space	<SP>	20h
Delay	<DLY>	Indicates delay due to internal drive processing of information

Communication Summary

Drive-to-Terminal Transmission	Terminal-to-Drive Transmission	Protocol Flags (Variables)
• Character echoes • Prompts • Variable values • Error/fault messages	• Commands • Variable values • Variable queries	ECHO MSGPROMPT CHECKSUM

10.2 Data Transmission Format

To enable proper serial communication between the MSHD and the host, they must both use the same data transmission format:

- Full-duplex
- 8 bits per character
- No parity
- 1 start bit
- 1 stop bit
- Baud rate: 115200 bps
- Hardware: RS-232 or USB serial port

10.3 Drive Addressing

The MSHD can be addressed and controlled on a single-line RS-232 (C7 connector), or on a daisy-chained RS-232 (C8 connector), or USB (C1 connector) line.

The MSHD has two 10-position rotary switches, which are used to set the drive address. Refer to the section Set the Drive Address.

Single-Line Configuration

In a single-line RS-232 configuration, the drive is connected to the C7 connector, and assigned address 0 by setting both rotary switches to 0.

By default, the rotary switches are set to 0, and the drive assumes a single-line configuration.

Daisy-Chain (Multi-Drop) Configuration

In a daisy-chain RS-232 configuration, all drives must be daisy-chained through the C8 connector. Each drive must have a unique address to enable its identification on the network.

A daisy-chained drive can be assigned an address from 1 to 99 by setting the rotary switches on the drive. When configuring a daisy-chain, address 0 cannot be used.

You can communicate with any or all drives on the daisy-chain from any RS-232 or USB port on any of the daisy-chained drives.

- To communicate with an individual drive in a daisy-chain, enter the following at the prompt:

```
\x <CR>
Where x = 1 to 99, the address setting of the drive.
```

- To communicate simultaneously with all drives on the chain, enter the following at the prompt:

```
\* <CR>
```

This is called global addressing. When using global addressing, no character echo to the terminal occurs.

10.4 Variables and Commands

Serial communication with the MSHD is by means VarCom, a proprietary set of commands and variables used to configure, control and monitor the drive.

- Commands instruct the drive to perform an operation.
- Read-only variables are calculated and/or set by the drive, and are used to monitor the drive and its operational status.

  To read a variable, type the name followed by a <CR>. The drive returns the value of the variable.
- Read/Write variables are used to configure and monitor the drive.

  To set a variable, type the variable name (VarCom mnemonic), a space (or =), the value, fol-

lowed by <CR> (the Enter key).

10.5 Data Control

The MSHD can process approximately 16 characters per millisecond (at 115200 baud rate). The operating system recognizes backspaces and resets upon receipt of an ESC character. The following VarCom variables allow you to configure communication responses between drive and host.

ECHO	Enables/disables the serial port character echo. If echo is enabled, characters received via the serial port are echoed back to the serial port and displayed on the computer monitor. ECHO 0 = Serial port echo disabled ECHO 1 = Serial port echo enabled ECHO allows the host to check the validity of the information received by the drive.
MSGPROMPT	Defines whether asynchronous messages and the prompt from the drive are sent to the serial port (and to the host computer) 0 = Messages and prompt disabled 1 = Messages and prompt enabled
CHECKSUM	Enables/disables checksum protection on the message. 0 = Message checksum disabled (default) 1 = Message checksum enabled The checksum is an 8-bit value, displayed within brackets <>. For example, 0x1F checksum is displayed as <1F> at the end of the message before the carriage return.

10.6 Message Format

The message format is the structure by which the MSHD processes ASCII coded messages. Messages from the host to the drive are used to send commands, to set variables, or to query the drive. Messages from the drive to the host contain the response to queries.

This message format has two main elements: message unit and message termination, as shown in the following figure.

The checksum utility is optional.

Note: Start has no significance; it

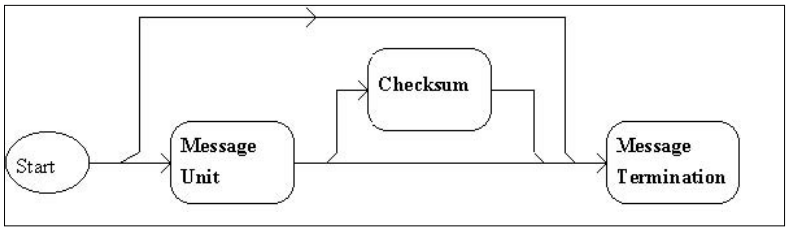


Figure 10-1.

Message Unit

A message unit is a block of information that is transmitted on the communications link. The basic message unit is shown in the following figure.

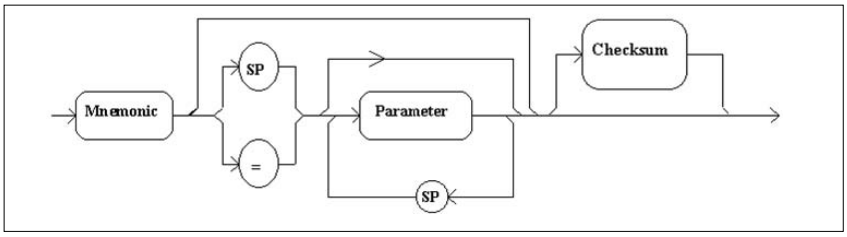


Figure 10-2.

A message unit includes a header (VarCom mnemonic) with or without parameters. The header defines the context of the parameters that follow it. Messages sent from the host to the drives always have headers. Messages from the drive to the host do not generally include a header.

When used, parameters are separated from the mnemonic by either a space or an assignment operator. Parameters must be separated by spaces.

The MSHD can receive only a single message unit in a message format.

Message Termination

Message termination refers to the end of the message being sent.

Messages transmitted by the host are terminated by a carriage return (CR) – ASCII character 0DH.

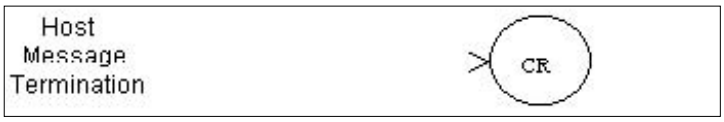


Figure 10-3.

Messages transmitted by the drive are terminated by a carriage return/line feed (CR/LF) combination – ASCII characters 0DH/0AH.

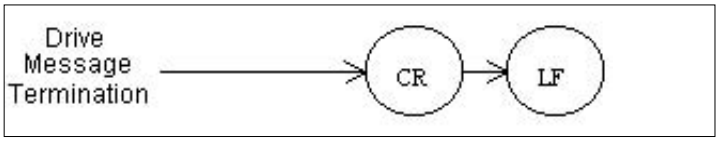


Figure 10-4.

The drive also accepts a message termination sent without any additional information.

Complete Message Format with Checksum

The CHECKSUM block is used only when CHECKSUM command is set.

The drive is configured to accept incoming messages with or without checksum, and to append checksum to outgoing message according to the CHECKSUM variable.

Checksum is represented by two ASCII digits within brackets <> preceding the

<CR>.

The complete message format is shown in the following figure.

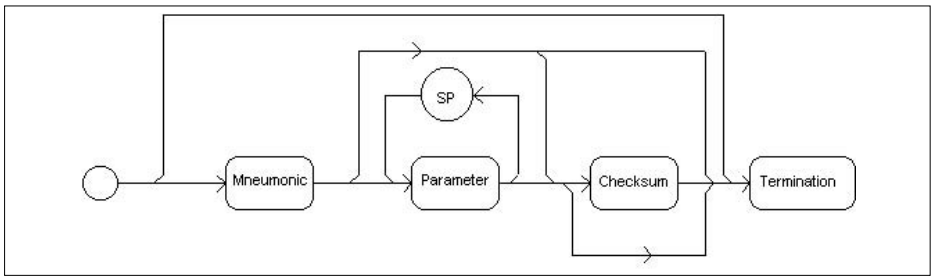


Figure 10-5.

Units

Within a message or command, units are enclosed in brackets [ ]. For example:

- Message to drive: mpoles
- Message from drive: 4 [poles]

When a command from the host contains units, the drive ignores the unit information.

10.7 Asynchronous Error Messages

The asynchronous error message function is enabled by the variable MSGPROMPT.

- If this function is enabled, and an error or fault occurs, the drive transmits a brief error message to the host.
- If the function is disabled, the error message is transmitted after a <CR> message termination is detected by the drive. This occurs whenever the host sends a message to the drive.

The variable MSGPROMPT also controls the prompt sent by the drive at the endof a message.

- If echoing is enabled, the characters in the message are all echoed before the error message is transmitted. Even though an error has occurred and its message returned to the host, the drive still accepts new incomingmessages and attempts to execute them.
- If echoing is disabled, the error message is transmitted after the <CR>message termination is detected by the drive.

The drive must detect a new error or fault before transmitting an error message.

10.8 Examples of MSHD Serial Protocol

The following examples demonstrate serial protocol between the MSHD and a host.

Issuing a Command or Variable

In Examples 1 through 5, MSHD parameters are defined as:

```
ADDR 0
CHECKSUM 0
ECHO 1
MSGPROMPT 1
```

Example 1 – Command

EN (drive enable)

Sequence #	1	2	3	4	5	6	7	8	9	10	11
User Enters	E		N		<CR>						

Drive Returns		E		N		<CR>	<LF>	<DLY>	-	-	>

Displayed on terminal:

-->EN

-->

Example 2 – Command/Variable - Returns Multiple Lines of Values

This type of command typically has a longer delay due to the large amount of data that is output to the screen.

DUMP (return drive parameter values)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	D		U		M		P		<CR>	
Drive Returns		D		U		M		P		<CR>

Sequence #	11	12	13	14	15	16	17	18
User Enters								
Drive Returns	<LF>	<DLY>	<VAR1>	<SP>	<VAL1>	<CR>	<LF>	<VAR2>

Sequence #	19	20	21	22	23	24	25	26
User Enters								
Drive Returns	<SP>	<VAL2>	<CR>	<LF>	<VARn>	<SP>	<VALn>	<LF>

Sequence #	27	28	29	30
User Enters				
Drive Returns	<CR>	-	-	>

Displayed on terminal:

```
-->DUMP
-->var1 val1
-->var2 val2
-->varn valn
```

Example 3 – Command/Variable - Returns Multiple Values

J (jog)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	J		<CR>							
Drive Returns		J		<CR>	<LF>	<DLY>	<VAL1>	<SP>	<VAL2>	<CR>

Sequence #	11	12	13	14
User Enters				
Drive Returns	<LF>	-	-	>

Displayed on terminal:

```
-->J
-->nnnnn nnnnn
-->
```

Example 4 – Reading a Variable Value

MPOLES (single pole motor with value 2)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	M		P		O		L		E	
Drive Returns		M		P		O		L		E

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	S		<CR>							
Drive Returns		S		<CR>	<LF>	<DLY>	2	<SP>	[	p

Sequence #	21	22	23	24	25	26	27	28	29	30	31
User Enters											
Drive Returns	o	l	e	s	]	<CR>	<LF>	<DLY>	-	-	>

Displayed on terminal:

```
-->MPOLES
2 [poles]
-->
```

Example 5 – Defining a Variable Value

ACC (acceleration with value 50000)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	A		C		C		=		5	
Drive Returns		A		C		C		=		5

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	0		0		0		0		<CR>	
Drive Returns		0		0		0		0		<CR>

Sequence #	21	22	23	24	25
User Enters					
Drive Returns	<LF>	<DLY>	-	-	>

Displayed on terminal:

```
-->ACC=50000
-->
```

Multi-Drop Mode

In Examples 6 and 7, MSHD parameter values are defined as:

```
ADDR 3
ECHO 1
MSGPROMPT 1
```

Example 6 – Addressing a Daisy-Chained Drive

The range of values for ADDR is 0 to 99. A value other than 0 puts the system in Multi-drop mode, which results in a different prompt.

Sequence #	1	2	3	4	5	6	7	8	9	10	11
User Enters	\		3		<CR>						
Drive Returns		\		3		<CR>	<LF>	<DLY>	3	-	>

Displayed on terminal:

```
-->\3
3->
```

Example 7 – Reading a Variable

IMAX (drive current limit)

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	I		M		A		X		<CR>	
Drive Returns		I		M		A		X		<CR>

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters										
Drive Returns	<LF>	1	5	.	6	9	7	<CR>	<LF>	<DLY>

Sequence #	21	22	23
User Enters			
Drive Returns	3	-	>

Displayed on terminal:

```
-->IMAX
3->15.697
3->
```

Serial Checksum

Example 8 – Variable

In this example, MSHD parameters are defined as:

```
ADDR 0
CHECKSUM 1
ECHO 1
MSGPROMPT 1
```

ACC (acceleration) with value 25000

Sequence #	1	2	3	4	5	6	7	8	9	10
User Enters	A		C		C		=		2	
Drive Returns		A		C		C		=		2

Sequence #	11	12	13	14	15	16	17	18	19	20
User Enters	5		0		0		0		<	
Drive Returns		5		0		0		0		<

Sequence #	21	22	23	24	25	26	27	28	29	30	31
User Enters	F		B		>		<CR>				
Drive Returns		F		B		>		<CR>	-	-	>

Character	Hex Value	ASCII Value
A	41	65

C	43	67
C	43	67
=	3D	61
2	32	50
5	35	53
0	30	48
0	30	48
0	30	48

```
Checksum=0xFF& (0x41+0x43+0x43+0x3d+0x32+0x35+0x30+0x30+0x30)
=0xFF & 0x01FB=0xFB
```

Note: Enter the last two characters of the HEX VALUE sum before the <CR>. Between brackets < >

Displayed on terminal:

```
//setting the checksum
-->CHECKSUM 1
//sending command to the drive with checksum appended
-->ACC=25000<FB>
//checking the actual value stored at the drive
-->ACC
//the reply is appended by checksum
25000.000[rpm/s]<7E>
-->
```

11 Contacting MOONS'

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